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AMERICAN ASSOCIATION OF ECONOMIC ENTOMOLOGISTS

PAPER-READING SESSION, FORTY-NINTH ANNUAL MEETING

Atlantic City, N. J., December 1936

Effects of Nicotine Fumigation at Short Exposure and Assumed High Concentration[1]

J. F. ALSTERLUND, *Illinois Natural History Survey* and *Illinois Agricultural Experiment Station*, and C. C. COMPTON, *Illinois Natural History Survey, Urbana*

ALTHOUGH nicotine has long been used as a fumigant, very little has been published concerning methods of employing it to best advantage. This paper presents evidence from a series of experimental greenhouse fumigations, together with data from outdoor field fumigation of the pea aphid, which indicates that nicotine vapor is most efficient as an aphicide if an assumed high concentration of fumes is built up for a relatively short period, rather than maintaining a weaker dosage over a longer exposure. The qualification "assumed high concentration" is made since no reliable method of quantitatively sampling air for the presence of nicotine vapor was available.

Experimental greenhouse fumigations.—Experiments were conducted in the floriculture greenhouses of the University of Illinois. Houses were of 35,000 and 45,000 cubic feet capacity. The test insect was the black mum aphid, *Macrosiphum sanborni* Gilette. The aphids were reared on chrysanthemum and about an hour before each fumigation were transferred with a camel's-hair brush to cheesecloth cages. Well-grown, active, apterous individuals only were used. The cages were set along the raised benches about 18 inches above the soil, an average of five cages with approximately 40 aphids each being used for each fumigation. All fumigations were at a temperature of approximately 70° F, relative humidity 59 to 82 per cent, and of one hour's duration.

Materials.—*Nicofume* fumigating powder, consisting of 12.5+ per cent by weight of pure nicotine absorbed into a rapidly combustible base, was the source of nicotine throughout.

The purpose of the work was to evaluate a newly devised method of

[1]Nicotine insecticide investigation project.

greenhouse fumigation whereby the nicotine-impregnated powder is burned in cans instead of in open piles. In commercial practice these cans, in one-half pound and pound sizes, are set along the greenhouse walks. Two holes are punched in the opposite sides of the can and the powder ignited by dropping in a lighter supplied for the purpose.

The customary dosage of 1 pound of *Nicofume* powder per 25,000 cubic feet produces very high per cent kills of most greenhouse aphids. The black mum aphid, being somewhat resistant to nicotine fumigation, served as an excellent indicator of the comparative effectiveness of the several fumigation methods employed.

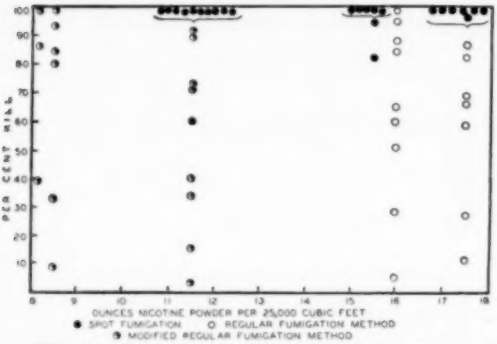
PER CENT KILL
OUNCES NICOTINE POWDER PER 25,000 CUBIC FEET
● SPOT FUMIGATION ○ REGULAR FUMIGATION METHOD
◑ MODIFIED REGULAR FUMIGATION METHOD

Fig. 1.—Effects of various methods of greenhouse fumigation with nicotine on *Macrosiphum sanborni*. Each circle represents a cage of approximately 40 aphids, with an average of five cages per fumigation.

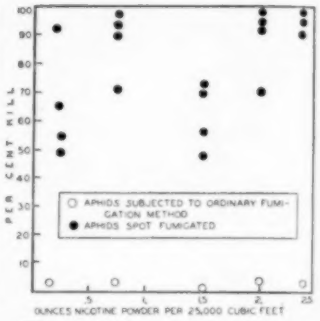
PER CENT KILL
○ APHIDS SUBJECTED TO ORDINARY FUMIGATION METHOD
● APHIDS SPOT FUMIGATED
OUNCES NICOTINE POWDER PER 25,000 CUBIC FEET

Fig. 2.—Comparison of spot fumigation and ordinary fumigation with nicotine, both at relatively low dosage, on *M. sanborni*. Numbers of individuals and cages as in fig. 1.

Figure 1 (regular fumigation method) shows typical erratic mortality recorded for *M. sanborni* in various cages of a series of fumigations conducted as in regular commercial practice, at the dosage satisfactory for most aphids. This variability in kill from cage to cage occurring in different parts of the same house during a fumigation was first assumed to be merely a matter of unequal distribution of the nicotine vapor. To improve the latter, a series of fumigations at quite low dosages was performed, fig. 1, modified regular fumigation method. In these the pressure cans, instead of being allowed to discharge from a stationary position on the walks, were moved slowly, while burning, through the length of the greenhouse, at some distance above the vegetation. Somewhat better mortality was obtained by this method, but the factor of variability remained.

It had frequently been observed that there was a persistently better kill in cages which happened to be near enough to a pressure can to be enveloped for a few seconds by the dense cloud of fumes produced in the initial discharge. To investigate this possibility, the following procedure was adopted: The commercial powder was diluted approximately one half by addition of nicotine-less base powder, in order to prolong the burning time. The mixture was placed in home-made pressure cans of one-half pound capacity, an average of .3 pounds of commercial powder

being used per 100 linear feet of greenhouse bench. One outlet hole only was punched. The cans were attached to a short stick and carried slowly along the walks, with the single discharge stream turned directly onto the foliage of the benches. In this way a temporarily dense cloud of fumes was built up above each bench. This cloud would hang for 30 to 60 seconds before dissipating throughout the house. Decidedly higher and more consistent per cent mortality was obtained by this method, especially when dosages in the neighborhood of one pound of powder per 25,000 cubic feet were used, fig. 1, spot fumigation.

Table 1.—Summary of percentage of kill and percentage of reinfestation in nicotine vaporizer treatment of pea aphid, *Macrosiphum pisi* (Kaltenbach), at Rochelle, Ill., 1936.

1	2	3	4	5	6	7	8	9	10	11
Station	Date	No. Live Aphids per Plant	Vaporizer Date	Treatment Time of Day*	No. Live Aphids per Plant 1–2 Days after Treatment	Per Cent Kill	Per Cent Original Population (Column 3) Reinfesting			
							3–4 Days after Treatment	Per Cent Very Young Nymphs of Column 8	6 Days after Treatment	Per Cent Very Young Nymphs of Column 10
1	6/22	81.4	6/22	4 P.M.	2.4	97.0	14.7	90.1	Harvested	
2	6/22	74.6	6/22	6 P.M.	2.0	97.3	16.	75.1	Harvested	
3	6/22	212.4	6/23	10 A.M.	8.4	96.	6.7	44.5	Harvested	
4	6/22	166.0	6/23	11 A.M.	5.7	96.5	5.0	48.2	Harvested	
5	6/22	193.5	6/23	7 P.M.	.5	99.0	.7	31.8	3.1	67.7
6	6/22	141.5	6/23	10 P.M.	1.0	99.2	1.4	45.1	2.1	85.1
7	6/23	164.2	6/23	11 A.M.	2.2	98.6	1.7	38.6	2.9	53.6
8	6/25	123.4	6/25	2 P.M.	4.0	96.7	6.3	73.0	6.3	62.0
Average		*144.*			*3.2*	*97.6*	*6.5*	*55.8*	*3.6*	*67.0*

* For weather conditions at time of treatment see fig. 3.

Some doubt still remained as to whether the improved kills might not be due simply to more uniform distribution rather than to the factor of temporary heavy dosage. To test this, fig. 2, parts of houses were treated as follows: Cages were set on two adjoining benches. One bench was spot fumigated with a dosage which, when dispersed, would be extremely low for the entire house. The cages on the other bench were untreated except for the weak general fumigating effect, and amounted essentially to a check. The spot-fumigated cages only showed any appreciable kill.

Observations on field fumigation of pea aphid with nicotine vaporizer.—During the summer of 1936 the senior author was stationed at Rochelle, Ill., to observe the first large-scale field operation of the Nicotine Vaporizer, a machine developed by the Tobacco By-Products and Chemical Corp. for fumigation of low-growing crops with free nicotine.

Motive power for each vaporizer consisted of a light second-hand truck equipped with an extra-low gear. A small pump, capable of delivering accurately from one one-hundredth to 1 cc. of nicotine per stroke, was fitted to the speedometer shaft. The nicotine solution was carried in a special 7-gallon drum just back of the cab of the truck, from which source it was sucked by the pump and forced into the exhaust line near the rear end. The exhaust line was extended by means of a right angle 20-foot

boom having seven discharge holes equally distributed across its width.

A temperature of 500° F or higher was maintained in the exhaust line slightly to the rear of the nicotine inlet, insuring complete vaporization of the nicotine.

A muslin apron, 22 feet wide by 100 feet long, reinforced with heavy canvas, was attached to a separate supporting boom just above and ahead of the discharge boom. Both booms were demountable to permit travel from one field to another.

Dosage.—Dosage was 2.31 pounds of 100 per cent nicotine per acre, material used being a water solution containing 80 per cent actual nicotine.

Table 2.—Population count of pea aphid in check plot, June 22–28, 1936, at Rochelle, Ill.

1	2	3	4	5
Date	No. Plants Counted	No. Live Aphids per Plant	Per Cent in "Bud"	Per Cent Dead Aphids per Plant
6/22	10	108.7	53.0	.4
6/24	10	210.4	48.0	3.3
6/26	15	212.5	48.2	3.2
6/28	10	241.0	10.9	2.6

Speed of operation.—A speed of between 50 and 60 seconds per 100 feet, or a little faster than 1 mile per hour, was maintained. This gave a fumigation period of approximately one minute.

Method of making counts.—Actual counts of numbers of individual aphids per plant were made throughout. Regular procedure was as follows: A count was made to determine aphid population in some locality typical of the field, a few hours prior to treatment by the vaporizer, and this spot marked with a stake. When the vaporizer arrived at the stake in the course of fumigation of the field, one of the crew, without stopping the machine, removed the stake, recorded data on it, and replaced the stake in the center of wheel tracks. This spot was then counted for aphid population at regular intervals till harvest. A count of 10 plants was made prior to treatment, and a count of 15 plants was made following treatment—five plants in the area between the wheel tracks and five plants each in the area covered by the right and left extension of the canvas apron.

Eight such stations were established, data from which are given in table 1. Note the capacity of the pea aphid for rapid reinfestation, as expressed by the high proportion of young nymphs present in after-treatment counts, table 1, columns 9, 11.

Check plot.—An area about one-third of an acre, located in the same field as stations Nos. 3 and 4, was set aside for observation as the check plot.

It will be seen that from June 22 to 28, the period during which all stations of table 2 were treated, the aphid population approximately doubled. Note also that until close to harvest about half of the infestation is carried by the "bud," or terminal blossom with its cluster of folded leaves. Dead aphids found on the plants, table 2, column 5, due chiefly

to syrphid-fly predatism, never amounted to more than 3.3 per cent of the current population. Probably an additional number had been killed but had dropped from the plants and could not be estimated. No mortaility of significant proportions resulting from natural causes could be observed.

Weather conditions.—Hot, dry weather prevailed at Rochelle during the period of nicotine vaporizer treatment, fig. 3. A quite accurate

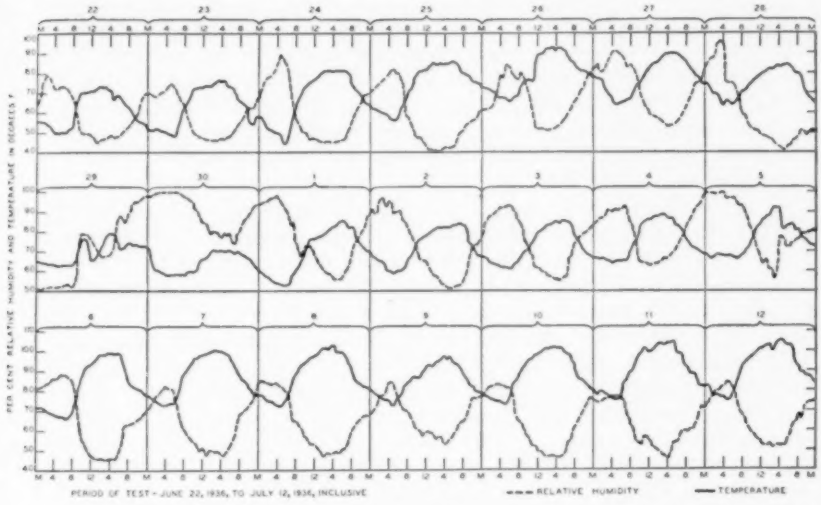
PER CENT RELATIVE HUMIDITY AND TEMPERATURE IN DEGREES F
PERIOD OF TEST - JUNE 22, 1936, TO JULY 12, 1936, INCLUSIVE
RELATIVE HUMIDITY
TEMPERATURE

Fig. 3.—Temperature and relatively humidity at Rochelle, Ill., for the period June 22 to July 12, 1936. Plotted quad-hourly from record sheet of hygrothermograph in standard weather box. Courtesy L. H. Shropshire.

estimate of the temperature and humidity at time of the individual vaporizer treatments can be made by taking the time of day from fig. 1, and matching it with the continuous meteorological record given in fig. 3.

Discussion.—The toxic action of the nicotine vaporizer in field fumigation of the pea aphid appears to be essentially similar to the spot fumigation of greenhouse aphids. In both cases there was a very short exposure to a comparatively dense concentration of nicotine vapor, with resulting high and consistent kill. In the greenhouse tests, the spot fumigation method was clearly superior to the traditional practice of allowing the nicotine vapor to diffuse equally throughout the house from stationary points.—6-1-37.

EFFECTIVE March 1, 1937, the federal quarantine and regulations relating to the Japanese beetle were revised to include in the regulated area the cities of Cleveland, Columbus and Toledo, also two entire Ohio counties and parts of three others in which the beetle has become established. Additional areas in Maine, Maryland, New York, Vermont, Virginia and West Virginia were also included. Some outlying areas where infestations have been found were not included, according to the Bureau of Entomology and Plant Quarantine, because of the assurance from the states concerned that adequate measures will be taken to prevent the spread of the pest therefrom.

Laboratory Apparatus for Fumigation with Low Concentrations of Nicotine

With Studies on Aphids

HENRY H. RICHARDSON and R. L. BUSBEY, *U. S. Department of Agriculture, Bureau of Entomology and Plant Quarantine*[1]

Although nicotine has been and is still used in large quantities as a fumigant in greenhouses, little work has appeared in the literature on the accurate determination of its toxicity in the gaseous condition to insects. The fumigating effect of nicotine is also undoubtedly involved in its toxic action when used as a spray or dust. Inasmuch as aphids are the main group of insects on which nicotine is used, such a study should include them if possible.

C. H. Richardson & L. E. Haas (1932) have made determinations of the toxicity of nicotine to the confused flour beetle, *Tribolium confusum* Duv., a resistant insect, in which concentrations of .1 to .42 mg. of nicotine per liter were used. An apparatus similar to that used by them, depending on the suction of air through nicotine, was tried on aphids by the senior author, but difficulty was experienced in obtaining accurately controlled concentrations of .01 mg. or less of nicotine per liter, which are needed in a study in which aphids are used. The air flow was difficult to control without noticeable variation at the very low air speeds (50 to 300 cc. per hour) needed in the nicotine saturator train of the apparatus. For these reasons a different type of apparatus was designed in which compressed air was used for obtaining the air flow.

Apparatus.—The apparatus, fig. 1, has a nicotine saturator train in which air is bubbled slowly through a small quantity of nicotine (1 cc.) and then mixed with air from the dilution line to obtain the nicotine concentration desired. The very low air speeds through the nicotine saturator are measured by counts of the bubbles, the volume of which was previously determined by means of a calibrated flow meter (Craig & Richardson 1930). The air through the dilution train is measured by means of of a flow meter, and great dilution is possible even though total air speeds are kept down to 6 liters per hour. Air flows are controlled by needle valves, and with these once set the flow is quite constant. The air for the nicotine saturator line is first reduced to a pressure of one-half pound by a pressure-reducing valve, fig. 1, *l*, then passed through 20 per cent sodium hydroxide in wash bottle *k* to absorb the carbon dioxide and through concentrated sulfuric acid in wash bottle *j''* to eliminate moisture, thence through needle valve *i* where the flow through the nicotine bubbler *f* is regulated. At the very low air speeds used one wash bottle was sufficient to lower the relative humidity although two or more may be needed where higher air speeds are used. From *f* the air, which now contains nicotine in the gaseous condition, is passed through a capillary tube, *g*, approximately 1 mm. in diameter—the opening at the end of which is pointed in the direction of the dilution air flow and approxi-

[1] The writers acknowledge the aid of A. H. Casanges, O. A. Nelson and L. D. Goodhue, all of the Bureau of Entomology and Plant Quarantine.

mately centered in the air stream on the supposition that better mixing with the dilution air will result. The capillary tube was used to prevent back currents of air into the nicotine bubbler and to remove any possible spray droplets, the probable presence of which was small at the slow air speeds used. Glass wool was not used in the mixing flask, as some indications were obtained that this adsorbed nicotine and interfered with obtaining the desired concentration. The dilution air was measured by the calibrated flow meter a'. The air is passed through bottles of sulfuric acid to give the desired relative humidity—glass wool being used in the traps

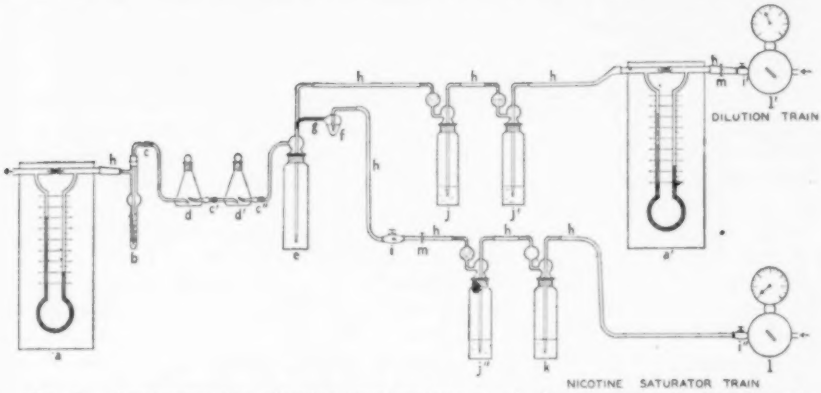

Fig. 1.—Apparatus for nicotine fumigation: *a*, *a'*, flow meters; *b*, nicotine absorber containing acid solution; *c*, *c'*, *c''*, ground-glass connections; *d*, *d'*, jars for confining insects; *e*, gas mixing jar; *f*, nicotine bubbler for vaporizing nicotine; *g*, capillary tube with end in center of air stream; *h*, rubber tube connections; *i*, *i'*, *i''*, needle valves for regulating air flow; *j*, *j'*, *j''*, wash bottles containing sulfuric acid for conditioning air, glass wool in traps; *k*, wash bottle containing 20 per cent NaOH; *l*, *l'*, pressure-reducing valves with gauge; *m*, *m*, Hoffman clamps.

to remove acid spray—thence into the mixing flask *e*. The nicotine–air mixture is passed into the fumigation chambers *d* and *d'* and thence into the nicotine absorber tube *b* containing weak acid solution. The outlet flow is measured through a calibrated flow meter, *a*, this being very useful in checking to be sure there are no loose connections or leaks and also in determining the bubble volume and checking the amount of air passing through the nicotine saturator in the higher flows.[2] Since nicotine is strongly absorbed by rubber (Harlan & Hixon 1928b), that portion of the apparatus through which nicotine was passed was made of *Pyrex* glass with interchangeable ground-glass joints at the connections *c*, *c'* and *c''*. The apparatus was kept inside a constant-temperature box at $77 \pm .9°$ F ($25 \pm .5°$ C), placed in a room which was also kept near this temperature.

[2] At flows of 4 liters or more per hour of the dilution air the reading of the outlet flow meter *a* was always slightly higher than that of the inlet flow meter *a'*, this difference being apparently due to and corresponding with the slightly higher pressure present in the train. When a suction apparatus like that of Richardson & Haas (1932) was used, a similar but greater difference was noted, the pressure inside the train being about 5 per cent below normal atmospheric pressure at the used air speeds of 10 to 12 liters per hour. An advantage of the compressed-air apparatus was that the difference in pressure with normal atmospheric pressure in the fumigation jars was less than with the suction apparatus at the same 6-liter per hour rate of air flow—1 per cent above as compared with 3 to 4 per cent below normal atmospheric pressure.

Nicotine concentration.—The nicotine concentration was determined by analysis of the gas, the nicotine being first absorbed in .5 N hydrochloric acid solution in the efficient absorber developed by J. R. Spies and then analyzed by the junior author using Spies' (1937) micro silicotungstic acid method. In a series of nine tests, in which the air was passed only through the saturator, the chemical analyses showed concentration of .273 to .309 mg. of nicotine per liter, averaging .289 mg. Analyses were also made to check the nicotine concentration obtained when making dilutions, and in these the results of a series of six tests ranged from .23 to .285 with an average of .261 mg. of nicotine per liter. The grand average of the two series gave a concentration of .278 mg. of nicotine per liter[3] and this figure was used in calculating the concentrations obtained in the insecticidal tests. The nicotine concentration did not appear to vary over the range of speeds through the saturator line up to 3 liters per hour. The above values for the vapor concentration obtained by bubbling air through nicotine are intermediate between the saturation values (77° F or 25° C) of .42 mg. found by Richardson & Haas (1932) where the nicotine concentration was determined by loss of weight, and that of .18 mg. found by Harlan & Hixon (1928) by analyses of the vapor. Our values were obtained over a period of several weeks with two different samples of nicotine (1 cc. each) which were prepared by distillation under vacuum and analyzed 99.39 per cent. Both samples changed from water white to amber as the tests went on. However, the later results with the darker, oxidized sample (analyzing 95 per cent[4]) did not differ significantly in nicotine concentration from that given by the water-white product, indicating that in these tests small quantities of impurities did not have a significant effect on the vapor concentration obtained.

Materials and method of exposure.—The insects used were the adults of three species of Aphiidae. The peach aphid, *Myzus persicae* Sulz., from nasturtium; the pea aphid, *Illinoia pisi* Kalt., from pea; and the bean aphid, *Aphis rumicis* L.,[5] from nasturtium. These were reared in the greenhouse and at the time of the experiment were transferred by camel's-hair brush to small test tubes where they were kept at 77° F for 1 to $2\frac{1}{2}$ hours before the test.

In starting the experiments needle valve *i'* of the dilution train was adjusted to give an air flow indicated on flow meter *a'* of approximately 6 liters per hour. The adjustment on the reducing valve after it had been set was left that way for the duration of the experiments and air flows were controlled by the needle valve. After needle valve *i''* was turned on, the air flow through the nicotine saturator was brought to the desired rate by means of needle valve *i*. The final adjustment was not made until after approximately five minutes so that the air flows through the train would be stablized. Flow meter *a* was checked closely throughout this period to make sure that there were no leaks or loose stoppers or connections. For the very low concentration of nicotine used in these experi-

[3] Using a 4-bulb saturator in a suction apparatus similar to that described by Richardson & Haas (1932), four analyses of our tests showed results ranging from .305 to .351 and averaging .325 mg. of nicotine per liter. The pressure inside the train was about 717 mm.

[4] Last two analyses by L. N. Markwood, Division of Insecticide Investigations.

[5] Aphids identified by P. W. Mason, Division of Insect Identification.

ments it was found necessary to give the apparatus a sweep-out of 1½ to 2 hours before making the tests at low humidity (see results in fig. 2).

After each day's series of tests the fumigation jars and mixing flask were washed with acid-cleaning solution, rinsed well and dried over night in an oven at 105° C so that no nicotine remained in the apparatus. When running a series with different concentrations the tests were made in the order of increasing concentration or if a lower concentration was to follow, the apparatus was cleaned and dried before it was used again.

After a sufficient sweep-out, the Hoffman clamps *m* and *m'* were closed, the flows allowed to slow down, and the jars *d* and *d'* removed. The stoppers were removed, and the aphids, usually 50 in number, quickly transferred. The aphids were kept well shaken down in the small test tube,

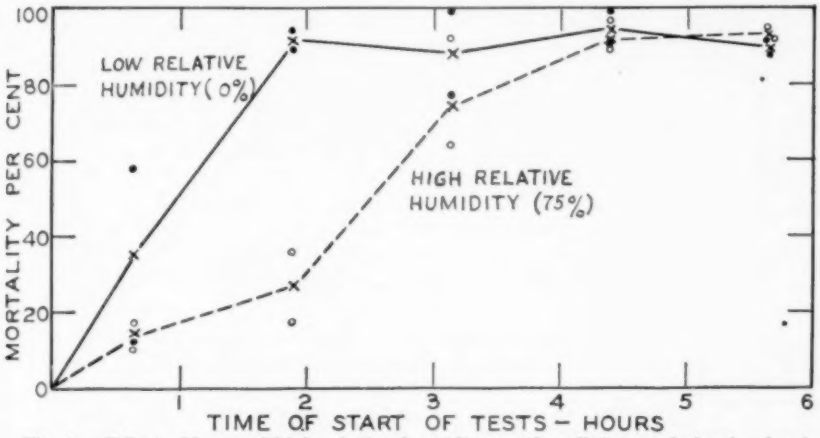

Fig. 2.—Effect of low and high relative humidity on the efficiency of nicotine fumigation against the peach aphid, *Myzus persicae*, from nasturtium. Nicotine concentration .0052 mg. per liter in all tests (30-minute exposures). Total air speed approximately 6 liters per hour in all tests.

the opening of which fitted inside the neck of the fumigation jar, and a slight shake would dump the entire lot into the jar. After the transfer the stoppers were quickly replaced and the jars set in the train. The clamps *m* and *m'* were released in that order, and the air flows came back to the previously adjusted rate. Half-hour exposures were used in all the tests in the present study, the Hoffman clamps being closed after this period, the fumigation jars removed, and the aphids transferred onto a leaf of their food plant set in a small tin cylinder provided with cheesecloth top and bottom. The leaf petiole was sealed with a paraffin–beeswax mixture into a small vial containing water. The cylinders containing the aphids were transferred carefully into a constant-temperature box at 77° F and 65 to 70 per cent relative humidity. Two small openings were provided in the box so that a constant though slow change of air would be going on all the time, and the fan in the box was set so that air movement would be very slight. Counts of the number of dead aphids were made after 24 hours. All aphids that could not walk after that time were called dead, as it was shown by repeated tests over periods up to

four days that none of these recovered. The tests on each day were accompanied by two untreated check samples of 25 aphids each. The peach aphid, *Myzus persicae*, was used largely in this study, and as only a very small percentage (.56 per cent of 710 aphids) died in the untreated checks, no allowance for these was made in calculating the efficiency of the treatment. The same practice was followed with the bean aphid. The mortality in the untreated checks for the pea aphid was higher, and was taken into consideration in calculating the net mortality. Relative humidity in the train was controlled by bubbling the air through sulfuric acid. A small quantity of potassium dichromate was added to each bottle of concentrated sulfuric acid to remove any sulfur dioxide

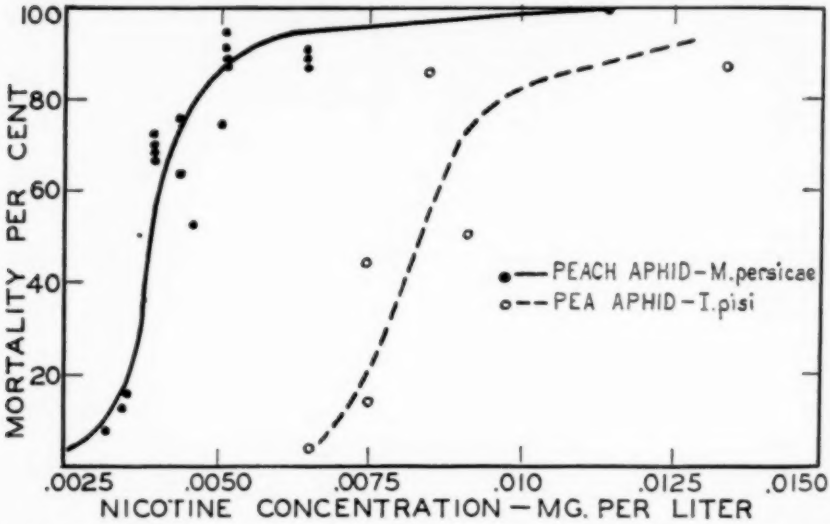

Fig. 3.—Toxicity of nicotine fumigation toward two species of aphids, *Myzus persicae* from nasturtium and *Illinoia pisi* from pea (30-minute exposures).

that might be evolved owing to impurities.[6] Relative humidity was checked by the use of the silver cup dew-point apparatus, the 30 per cent sulfuric acid giving 75 per cent relative humidity. With concentrated sulfuric acid no dew point was obtained at as low as 10° F (air temperature 82° F) and it was assumed that the relative humidity was approximately the theoretical zero.

Reproducibility of tests.—The reproducibility of the tests on any one day can be seen by examination of the data in figs. 2 and 3. The results at low humidity in fig. 2 can be seen to be quite consistent after the sweep-out period of 1.9 hours. In fig. 3 the four series with the peach aphid at nicotine concentrations of .0035, .0041, .0052 and .0065 mg. per liter were each made on separate days, and the results as shown are quite consistent. The results on different days within a period of a month or

[6] A series of tests on the filtration of the compressed air by an activated charcoal filter for removal of oil vapor or other impurities possibly present showed no difference in filtered or unfiltered air as used in these experiments on the toxicity of nicotine gas to aphids.

more did not vary greatly, but for any close comparative study the tests are best made, if possible, on the same or successive days.

Effect of relative humidity on efficiency of nicotine.—Richardson & Haas (1932) state that wide differences in relative humidity had little if any effect on the efficiency of nicotine against the confused flour beetle. A high relative humidity, however, has often been recommended in the past for nicotine fumigations under greenhouse conditions (McDaniel 1931).

The first tests with aphids indicated that mortality would be much greater with low than with high humidity. In one series at a nicotine concentration of .0044 mg. per liter the mortality was 63 and 75 per cent in consecutive tests at low humidity (near 0 per cent relative humidity) but fell to 9 per cent followed by 30 per cent at high humidity (75 per cent relative humidity). In another series at .0051 mg. concentration the mortalities were 55 and 84 per cent at low humidity, followed by 10 and 50 per cent kill at high humidity (a 1.75-hour sweep-out period was used before starting the high humidity tests). In still another series the figures were 100 and 96 per cent kill at low humidity, followed by 16 and 90 per cent at high humidity. It was noticed in most of the tests that mortality was at first very much lower under high humidity but that it increased in the later tests. Two long series on consecutive days were then run, both at the same concentration of .0052 mg. nicotine per liter, but with one at approximately 0 per cent and the other at 75 per cent relative humidity. Five sets of one-half hour tests in duplicate were run at each humidity, the first beginning at .65 hour after the air flows were started, the second at 1.9 hours, the third at 3.15 hours, the fourth at 4.4 hours, and the fifth at 5.65 hours. A preliminary 15-minute sweep with air alone at 75 per cent relative humidity was made in the high humidity series. The results are shown in fig. 2.

The maximum kill with approximately 0 per cent relative humidity was reached in 1.9 hours whereas with 75 per cent relative humidity the maximum kill was not reached until 4.4 hours; but after that mortality was just as great with high as with low humidity. Under the high humidity conditions there was another factor present, possibly absorption of the nicotine by the heavier film of moisture presumably present though invisible on the inside of the fumigation chamber, but after this factor had been satisfied the efficiency of nicotine appeared to be just as great at high as at low humidity. These results were obtained in a system in which the nicotine concentration was continually being renewed and held constant by a current of nicotine–air mixture sweeping through the apparatus. If the differences are so distinct under these conditions it would seem probable that under static conditions where one dosage is used, such as in a greenhouse fumigation, the differences would be still greater. *Myzus persicae* was used in all the foregoing tests, but similar results were obtained in other tests with *Illinoia pisi*.

Resistance of different species of aphids to nicotine.—Most of the tests were made with the peach aphid, *Myzus persicae*, and a graph is shown in fig. 3 which gives a concentration mortality curve for this species. The data for this curve were gathered intermittently over a period of $1\frac{1}{2}$ months, and the curve is fitted by hand.

Resistance of the pea aphid, *Illinoia pisi*, was also tested; and some of the work, done over a period of two weeks, is included with a hand-fitted curve. These tests as well as others indicate definitely that the pea aphid was more resistant to nicotine than the peach aphid. Some tests with the bean aphid, *Aphis rumicis*, indicated that it was somewhat less resistant than *Myzus persicae*, the median lethal point being near .0035 mg. of nicotine per liter.

Summary.—A laboratory apparatus is described in which air flows varying in nicotine concentration from 42 to one-quarter parts per million (.278 to .0016 mg. per liter) have been obtained, thereby making possible toxicity studies with aphids. Still lower concentrations may evidently be obtained if desired. Glass containers with ground-glass connections are used in that part of the apparatus through which nicotine gas flows. Compressed air regulated by needle valves and measured by calibrated flow meters is used for air flows. Nicotine concentrations were determined by microchemical analysis of the gas. One-half hour exposures at 77±.9° F were used in all tests. Nicotine fumigation was at first much more effective at low relative humidity than at high. Possibly the absorption of the nicotine by the presumably heavier film of moisture present, though invisible, on the inside of the fumigation chamber under high humidity conditions would account for the lower mortality, for after sufficient nicotine has passed through the chamber the fumigation is just as effective at high as at low relative humidity. Concentrations of one part nicotine per million parts air (.0066 mg. per liter) killed large numbers of the peach aphid, *Myzus persicae*, from nasturtium which were used in most of the tests. The bean aphid, *Aphis rumicis*, from nasturtium was somewhat less resistant than *M. persicae* whereas the pea aphid, *Illinoia pisi*, from pea was more resistant.—5-21-37.

Literature Cited

Craig, L. C. and C. H. Richardson. 1930. The calibration of flow meters for the measurement of insecticide gases. Jour. Econ. Ent. **23**(6):988–91. Illus. Dec.

Harlan, W. R. and R. M. Hixon. 1928a. Volatility of nicotine. Indus. & Engin. Chem. **20**(7):723–4. July.

Harlan, W. R. and R. M. Hixon. 1928b. Chemical testing of nicotine dusts. Iowa State Coll. Jour. Sci. **2**(4):313–16. July.

McDaniel, E. I. 1931. Insects and allied pests of plants grown under glass. Mich. Ag. Exp. Sta. Spec. Bul. **214**. 117 pp., illus.

Richardson, C. H. and L. E. Haas. 1932. The relative toxicity of pyridine and nicotine in the gaseous condition to *Tribolium confusum* Duval. Iowa State Coll. Jour. Sci. **6**(3):287–98. Illus. Apr.

Spies, J. R. 1937. Determination of small quantities of nicotine by a silicotungstic acid micromethod. Indus. & Engin. Chem. Analyt. Ed. **9**(1):46–7.

Tomato pinworm quarantines of Oregon and Washington were recently modified by eliminating Texas from the list of states designated as infested with the pest.

Recently enacted sections of the Missouri Plant Law provide for the appointment of a state entomologist in lieu of a plant officer, for the purpose of carrying out certain duties including the promulgation of quarantines and the inspection of nursery stock.

Arrangements for enforcing state quarantines under the terminal inspection procedure as provided by the Buck amendment of June 4, 1936, were recently made by California, Mississippi and Oregon.

Effect of Different Soaps on Formation of Soluble Arsenic from Lead Arsenate in Soft and Hard Waters

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Water-soluble soap is a spreading and wetting agent that has been extensively used for many years with contact insecticides, especially with nicotine and pyrethrum sprays in soft water. During the last three years certain soap manufacturers began to advocate the addition of fish-oil soap in various concentrations to lead arsenate sprays as spreader, sticker and corrective. Their recommendations were apparently based on results obtained in the Shenandoah apple growing region. While water-soluble soaps are undoubtedly efficient spreaders, especially in soft waters, one would hardly expect them to be good stickers. As a matter of fact, due to their high wetting properties they may increase the amount of surface run-off of solids during spraying, especially in soft waters, and actually reduce the quantity of lead arsenate deposited on foliage.

In the late summer of 1935 the writer, together with Dr. T. J. Headlee and Dr. B. F. Driggers, visited several apple orchards near Winchester, Va., where Dr. W. S. Hough conducts his experiments. Observations have disclosed that in blocks where potassium fish-oil soap was mixed with the acid lead arsenate sprays, the arsenical injury to foliage was materially reduced when compared with blocks of trees sprayed with lead arsenate containing no soap. The differences were distinctly indicated by the smaller per cent of defoliation where soap was employed.

These results appeared to the writer, on the first thought contrary to expectations. It is a well known fact, demonstrated by several investigators (Tartar & Bundy 1913; deOng 1921; Pinckney 1923; Ginsburg 1933), that water-soluble soaps react with acid lead arsenate and may produce soluble arsenic by the following reactions.

$$PbHAsO_4 + 2C_{17}H_{33}COOK = K_2HAsO_4 + (C_{17}H_{33}COO)_2Pb.$$

$$5PbHAsO_4 + 4C_{17}H_{33}COOK + H_2O = Pb_5OH(AsO_4)_3 + 2K_2HAsO_4 + 4C_{17}H_{33}COOH.$$

It is an equally established fact that arsenical injury to foliage is primarily due to soluble arsenic. It would therefore be logical to assume that the addition of soap to lead arsenate should augment, rather than decrease foliage injury.

The only explanation which had presented itself was that the hard water of this limestone region, which is indirectly responsible for arsenical injury, may neutralize the soap. Water hardness is caused by soluble salts of calcium, magnesium and iron and is commonly expressed as $CaCO_3$ parts per million. Two types of hardness are generally recognized: temporary, due to bicarbonates; and permanent, due to carbonates, sulfates and chlorides. The sum of the two constitutes total hardness. All these salts, except perhaps certain sulfates, may decompose

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lead arsenate forming soluble arsenic by chemical reactions such as the following:

$$PbHAsO_4 + MgCO_3 = PbCo_3 + MgHAsO_4.$$
$$PbHAsO_4 + CaCl_2 = PbCl_2 + CaHAsO_4.$$

On the other hand, water-soluble soaps also react with the salts of hard water, forming insoluble soaps of calcium or magnesium by the following reaction.

$$2C_{17}H_{33}COOK + CaCl_2 = 2KCl + (C_{17}H_{33}COO)_2Ca.$$

The presence of soap may therefore prevent the salts of the hard water from decomposing the lead arsenate.

Aside from the scientific interest, this problem also became of immediate economic importance because many apple growers in New Jersey, apparently influenced by soap manufacturers, began to inquire

Table 1.—Composition of laboratory prepared hard waters and soluble arsenic formed from lead arsenate.

$CaCl_2$	Per Cent $MgSO_4$	$NaHCO_3$	Approximate Hardness as $CaCO_3$ P.P.M.		Per Cent Soluble Arsenic As_2O_3
			Temporary	Total	
.07	.028	.035	215	900	1.97
.035	.014	.0175	108	450	1.22
.0175	.007	.0087	54	225	.8
.0087	.0035	.0044	27	113	.55

concerning the advisability of mixing fish-oil soap with sprays containing lead arsenate. Since arsenical injury to foliage may be caused by soluble arsenic formed in the spray mixture, the purpose of the experiments presented in this paper was to ascertain the effect of different soaps on the formation of water-soluble arsenic from acid lead arsenate in soft and hard waters.

Methods and materials.—In determining soluble arsenic, 2 gm. of acid lead arsenate were used in 500 cc. of water to which different soaps varying in concentrations from .0063 to .4 per cent were added. This amount of lead arsenate was approximately 3 pounds per 100 gallons.

Two general groups of soaps were tested: water-soluble soaps of potassium and sodium, and water-insoluble soaps (commonly designated as metallic soaps) of calcium, magnesium, aluminum, iron, lead and zinc. The purpose of testing the insoluble soaps (although heretofore not used with arsenical insecticides) was to study the rôle which they play when formed in spray mixtures of lead arsenate and soluble soap in hard water.

When water-soluble soaps were used, the soap was first dissolved in the water and the solution transferred to reagent bottles containing the weighed lead arsenate. When water-insoluble soaps were used the lead arsenate was first thoroughly mixed with the soap, transferred to the reagent bottle and the water then added. The mixtures in both cases were allowed to stand for 24 hours with frequent shaking and then filtered. The procedure from here on was exactly the same as outlined

in the *Official and Tentative Methods of Analysis of the Association of Official Agricultural Chemists* (1935). The following kinds of waters were used in the tests: distilled, rain, tap, Virginia hard (kindly supplied by Dr. W. S. Hough) and laboratory prepared waters, of different hardness containing varying concentrations of $MgSO_4$, $CaCl_2$ and $NaHCO_3$. The exact composition of these laboratory hard waters is given in table 1. Temporary and permanent hardness were determined as recommended in the Official Methods (1935). Seven different water-soluble fish-oil soaps and 15 insoluble metallic soaps were tested. Of the insoluble soaps 12 were secured from commercial sources and three, namely ferric stearate, calcium fish-oil soap and magnesium fish-oil soap, were prepared in the laboratory.

Table 2.—Percentage of soluble arsenic formed from lead arsenate in distilled water containing different soaps in varying concentrations.

Per Cent Anhydrous Soap	Potassium Pine Tar Soap	Potash Fish-oil Soap				Potassium Coconut-oil Soap	Potassium Rosin Fish-oil Soap	Sodium Fish-oil Soap
		No. 1	No. 2	No. 3	No. 4			
.20	4.48	4.62	4.74	4.20	4.70	3.92	2.91	
.15	3.24	3.46	3.98		3.82	2.46	2.48	4.52
.10	2.16	2.89	2.68	2.34	2.52	1.92	2.68	3.54
.05	1.08	1.54	1.48	1.33	1.42	1.11	1.36	2.42
.025	.61	.70	.61	.52	.66	.60	.83	1.16
.0125	.49	.50	.46	.42	.50	.42		.70
.0063	.44	.48	.45		.43			.49
Check, no soap	.25							

The insoluble soaps were prepared by treating 5 per cent solutions of the corresponding potassium soaps with dilute acetate solutions of iron, calcium and magnesium respectively. The resultant precipitates were washed with distilled water until free from acetates and soluble soap, dried and finely ground.

Of the seven water-soluble soaps used, four were different brands of fish-oil soap, varying from 25 to 31 per cent actual soap; one contained 7 per cent pine tar and a total of 37 per cent actual soap, known commercially as *Grandpa's Wonder Soap;* one rosin fish-oil soap of 50 per cent concentration; one sodium fish-oil soap, 42 per cent anhydrous, and one 40 per cent coconut-oil soap.

With each series of tests checks of lead arsenate alone were run. Each test was repeated at least twice while most of the tests were repeated several times. The average results are presented in the tables.

Water-soluble soaps in distilled water.—Tests with the different soluble soaps in distilled water, presented in table 2, have definitely shown that the addition of soap increases the soluble arsenic in proportion to the soap concentration. The increases became appreciable, as compared with the checks, when the soap concentrations reached .025 per cent or higher. No decided differences, however, were observed between the four samples of fish-oil soap and the one containing pine tar. In each case more than 4. per cent soluble arsenic was formed in mixtures containing .2 per cent soap. The rosin fish-oil soap and the coconut-oil soaps produced less, while the sodium soap produced more soluble arsenic than did the straight fish-oil soaps. These results may serve as additional evidence to

confirm the consensus of opinion prevailing among workers in this field that soap and lead arsenate are incompatible.

Water-soluble soaps in hard waters.—The next step was to determine the effect of hard waters with soap on lead arsenate. Since all the soluble soaps have in the previous tests reacted with lead arsenate practically in the same manner, the tests in hard waters were conducted only with two soaps, one from the fish-oil group and the one containing pine tar. The Virginia hard water, tap water and laboratory hard water were tested in comparison with distilled and rain waters.

Table 3.—Percentage of soluble arsenic formed from lead arsenate in waters of different hardness containing varying concentrations of soaps.

Per Cent Anhydrous Soap	Distilled Water	Tap Water $CaCO_3$ 40 P.p.m.	Virginia Hard Water	Laboratory Hard Water $CaCO_3$ 900 P.p.m.	Soft Rain Water
		Potassium Pine Tar Soap			
.2	4.2	2.14	.95		
.15	3.1		1.6		
.1	2.21	1.82	1.46		
.05	1.22	.75	1.78		
.025	.85	.54	1.77		
.0125	.49	.37	1.2		
.0063	.44	.42	1.55		
Check, no soap	.25	.36	1.8		
		Potassium Fish-oil Soap			
.2	4.72	1.97	.53	.71	5.5
.15	3.75	1.62	1.03	.69	4.4
.1	2.5	1.33	1.02	.64	2.9
.05	1.25	.72	.86	.55	1.4
.025	.63	.51	.96	.56	.66
.0125	.36	.5	1.3	1.5	.31
.0063	.30	.5	1.43	1.8	.3
Check, no soap	.25	.36	1.8	1.97	.18

The results presented in table 3 show that in hard waters both soaps had an opposite effect on lead arsenate than in soft waters. The hard water obtained from Virginia produce 1.8 per cent soluble As_2O_3 in the check and only .53 per cent and .95 per cent in solutions containing .2 per cent of the fish-oil and pine-tar soaps respectively. On the other hand, in soft rain water the soluble arsenic was .18 per cent in the check and 5.5 per cent in mixtures containing .2 per cent fish-oil soap.

Again, in the laboratory hard water the amount of soluble arsenic was reduced from 1.97 per cent in the check to .55 per cent in solutions containing .05 per cent fish-oil soap. These results definitely indicate that in hard waters the presence of soap makes lead arsenate safer on foliage, and may offer an explanation for the reduced defoliation in the Virginia orchards, resulting from the addition of soap to lead arsenate sprays. On the other hand, the addition of soap to soft waters may prove a dangerous procedure which may result in increased arsenical injury.

The tests with waters of different hardness, table 1, suggest a direct relationship between the degree of hardness and the decomposition of

lead arsenate. The water of the highest hardness has also formed the highest per cent soluble arsenic.

Effect of components of hard water.—The next step in this problem was to determine which salts of the laboratory hard water (for composition see table 1) are mainly responsible for the break-down of the lead arsenate. For this purpose soluble arsenic was determined in several samples of the hard water treated before the addition of lead arsenate, as follows: one untreated sample was tested with lead arsenate, which, of course, gave the effect of total hardness. A second sample was boiled for half an hour, cooled, filtered, made up to original volume with freshly boiled distilled water and tested. A third sample was neutralized with .05 normal sulfuric acid, boiled for about 15 minutes to expel free CO_2, cooled, made up to original volume with CO_2 free distilled water and tested. This procedure eliminated both bicarbonates and carbonates, leaving the chlorides and sulfates in solution. The results in table 4 show that 75 per cent of the total soluble arsenic was caused by the carbonates and bicarbonates while only 25 per cent could be ascribed to the chlorides and sulfates.

Table 4.—Effect of temporary and permanent hardness on forming soluble arsenic from lead arsenate.

	Hardness as $CaCO_3$ P.P.M.	Per Cent As_2O_3	Relative Values*
Soluble arsenic due to total hardness	900	1.97	100
Soluble arsenic due to total permanent hardness	685	1.28	65
Soluble arsenic due to temporary hardness or bicarbonates	215	.69	35
Soluble arsenic due to carbonates		.78	40
Soluble arsenic due to sulfates and chlorides		.5	25
Soluble arsenic due to carbonates and bicarbonates		1.47	75

* The per cent As_2O_3 from total hardness was considered as 100.

These analyses further suggest that waters of equal total hardness may react differently with lead arsenate, depending on the kinds of salts in solution. It may be generally stated that a water of high temporary hardness due to bicarbonates or of high permanent hardness due to carbonates will form higher amounts of soluble arsenic than a water low in these components, although of the same total hardness. Generally, hardness caused by sulfates will have little effect on the lead arsenate, as shown by recent experiments conducted by the writer but not yet published.

Water-insoluble soaps.—The rôle of water-soluble soaps in reducing the per cent of soluble arsenic formed from lead arsenate in hard waters is not fully explained by the chemical reaction involved. Assuming that the hardness is due to calcium carbonate the following reaction will take place in presence of potassium oleate:

$$CaCO_3 + 2C_{17}H_{33}COOK = K_2CO_3 + (C_{17}H_{33}COO)_2Ca.$$

While the calcium becomes tied up as an insoluble soap, potassium carbonate is formed in this reaction which should in its turn react with

Table 5.—Percentage of soluble arsenic formed from lead arsenate and hard water, ground by pestle in a mortar, with varying concentrations of different insoluble soaps.

Soap Tested	Per Cent Soap	Per Cent As_2O_3
Check, lead arsenate only in hard water	None	1.84
Check, lead arsenate only in distilled water	None	.15
Aluminum palmitate	.1	.74
Aluminum palmitate	.2	.3
Aluminum palmitate	.4	.3
Aluminum palmitate	.8	.12
Aluminum resinate	.2	1.79
Aluminum resinate	.4	1.69
Aluminum stearate	.1	.93
Aluminum stearate	.2	.53
Aluminum stearate	.4	.51
Aluminum stearate	.8	.55
Calcium oleate	.1	.61
Calcium oleate	.2	.14
Calcium oleate	.4	.1
Calcium stearate	.2	1.4
Calcium stearate	.4	.79
Calcium stearate	.8	.56
Calcium fish-oil soap	.1	.65
Calcium fish-oil soap	.2	.63
Calcium fish-oil soap	.4	.53
Lead stearate	.2	1.11
Lead stearate	.4	.87
Ferric stearate	.2	.95
Ferric stearate	.4	.88
Ferric stearate	.8	.73
Magnesium oleate	.2	1.51
Magnesium oleate	.4	1.05
Magnesium stearate	.2	2.02
Magnesium stearate	.4	1.86
Magnesium fish-oil soap	.1	.78
Magnesium fish-oil soap	.2	.66
Magnesium fish-oil soap	.4	.63
Magnesium fish-oil soap	.8	.56
Zinc oleate	.1	.18
Zinc oleate	.2	.11
Zinc oleate	.4	.17
Zinc palmitate	.1	.1
Zinc palmitate	.2	.14
Zinc palmitate	.4	.14
Zinc palmitate	.8	.14
Zinc resinate	.1	1.21
Zinc resinate	.2	.19
Zinc resinate	.4	.07
Zinc stearate	.1	.18
Zinc stearate	.2	.32
Zinc stearate	.4	.2
Zinc stearate	.8	.17

Table 6.—Minimum concentrations of insoluble soaps required to reduce to low levels soluble arsenic from lead arsenate in hard water.

Soap Tested	Per Cent Soap	Per Cent As_2O_3
Calcium oleate	.2	.14
Zinc oleate	.05	.18
Zinc palmitate	.05	.19
Zinc resinate	.1	.21
Zinc resinate	.05	.33
Zinc stearate	.1	.18
Zinc stearate	.05	.27
Aluminum palmitate	.8	.12
None	Check, lead arsenate in hard water	1.97
None	Check, lead arsenate in distilled water	.15

Table 7.—Soluble arsenic formed from lead arsenate in hard-water filtrates of insoluble soaps.

Soap Tested	Per Cent Soap	Per Cent As_2O_3
Calcium oleate	.4	.44
Calcium stearate	.4	1.8
Aluminum stearate	.4	1.9
Aluminum palmitate	.4	1.7
Aluminum resinate	.4	1.8
Ferric stearate	.4	1.8
Magnesium oleate	.4	1.9
Magnesium stearate	.4	1.8
Zinc oleate	.4	.67
Zinc resinate	.4	1.7
Zinc stearate	.4	1.85
None	Check, arsenate only	1.9

Table 8.—Effect of insoluble soaps in reducing soluble arsenic in hard-water filtrates from lead arsenate.

Soap Tested	Per Cent Soap	Per Cent As_2O_3
Calcium oleate	.4	1.68
Calcium stearate	.4	1.6
Zinc oleate	.4	1.65
Zinc resinate	.4	1.25
Zinc stearate	.4	1.75
None	Check, arsenate only	1.92

the lead arsenate to form soluble potassium arsenate (K_2HAsO_4). Theoretically, no decrease in soluble arsenic should result unless this secondary reaction is prevented by the fluffy, voluminous mass of the metallic soap either occluding the K_2CO_3 or forming a protective coat on the lead arsenate particles.

To test this hypothesis lead arsenate was intimately mixed in a mortar with various proportions of pure metallic soaps and analyzed for soluble arsenic in hard water of 900 $CaCO_3$ parts per million. The

results are presented in table 5. With the exception of magnesium stearate all the soaps have caused appreciable reductions in soluble arsenic as compared with the check. Of the 15 metallic soaps tested, aluminum palmitate, calcium oleate, and an oleate, palmitate, resinate and stearate of zinc have reduced the per cent of soluble arsenic to a figure close to that present in the check where distilled water was used.

The minimum amounts of these soaps necessary to bring about this reduction, given in table 6, ranged from .05 per cent for zinc oleate to .8 per cent for aluminum palmitate.

For these tests a different sample of lead arsenate was used which ran lower in soluble arsenic than the one tested with the soluble fish-oil soap giving an average of .15 per cent of soluble As_2O_3.

In order further to study the reactions involved, a series of tests were run with filtrates of 11 insoluble metallic soaps. For this purpose 2 gm. of soap were transferred to 500 cc. of hard water and allowed to stand for 24 hours with frequent shaking. The filtrates from these mixtures were then transferred to reagent bottles containing 2 gm. of lead arsenate and the soluble arsenic was determined in the usual manner. The results in table 7 show that of the 11 soaps tested only calcium oleate and zinc oleate reduced the soluble arsenic, analyzing .44 and .67 per cent As_2O_3 respectively as compared with 1.9 per cent found in the check. Later tests have disclosed that these two soaps were somewhat soluble in water. In the filtrates from the other soaps the per cent of soluble arsenic formed was practically as high as in the check where no soap was used.

In another series of tests the procedure was reversed. In this case 2 gm. of lead arsenate were allowed to remain for 24 hours in 500 cc. of hard water with frequent shaking. The filtrates were then transferred to reagent bottles containing 2 gm. of insoluble metallic soap and the soluble arsenic determined after 24 hours. The results in table 8 indicate appreciable reductions in As_2O_3 for all the five soaps tested. The largest reduction occurred with zinc resinate, analyzing 1.25 per cent As_2O_3 as compared with 1.92 per cent found in the check.

It should be noted that in none of the filtrates from either one of the two series was the reduction in soluble arsenic in any way comparable with the large reductions obtained when the lead arsenate was directly mixed with the insoluble soaps. Generally, these results seem to support the theory that certain water insoluble metallic soaps possess the properties of preventing the reaction between lead arsenate and chemicals producing hard water such as $CaCO_3$ and similar salts. In order to accomplish this, however, the soap must be in intimate contact with the lead arsenate.

Summary and conclusions.—Experiments were conducted with lead arsenate mixed with soluble and insoluble soaps in soft and in hard water for the purpose of determining to what extent soaps may safely be used as spreaders and correctives with arsenical sprays. The following results were obtained.

(1) Water-soluble soaps increase the soluble arsenic in soft water in proportion to the amount of soap added. (2) Hard waters form large amounts of soluble arsenic, especially when the hardness is due to carbonates or bicarbonates. (3) Soluble soaps, added to hard water,

prevent the formation of excessive amounts of soluble arsenic. (4) Soluble soaps react with the salts present in hard water, precipitating the corresponding insoluble soaps which apparently do not affect the lead arsenate. (5) Certain insoluble metallic soaps when added directly to the lead arsenate also prevent formation of water-soluble arsenic in hard water. (6) Of the various salts causing water hardness the bicarbonates and carbonates are primarily responsible for the production of soluble arsenic from lead arsenate. (7) While in hard water the presence of soluble soap may make lead arsenate safer on foliage, the addition of soaps to soft water may result in increased arsenical injury.—7-1-37.

Literature Cited

Association of Official Agricultural Chemists. 1935. Official and Tentative Methods of Analysis. Fourth Edition. Washington.

DeOng, E. R. 1921. Selection and treatment of waters for spraying purposes with especial reference to Santa Clara Valley. Cal. Ag. Exp. Sta. Bul. **338**:301–14.

Ginsburg, J. M. 1933. The effect of different soaps on lead arsenate in spray mixtures. Jour. Ag. Res. **46**(2):179–82. Jan.

Pinckney, R. M. 1923. Action of soap upon lead arsenates. Jour. Ag. Res. **24**(1):87–95, Apr.

Tartar, H. V. and L. A. Bundy. 1913. Soluble arsenic in mixtures of lead arsenate and soap. Jour. Indus. & Engin. Chem. **5**(7):561–62. July.

Homaledra sabalella Chambers, the Major Pest of Palms in Florida

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Economic importance.—In the United States the palms and palmettos are used as decorative plants in California. Texas, Louisiana, Alabama, Georgia, South Carolina and Florida. In almost all of the tropical countries they are used for the same purpose.

There is no one thing that adds more to the tropical beauty of Florida than does the palm. The palms line the streets of many of the cities and towns in the state. They are used in the planting schemes about many private homes in Florida and certain native species may be seen growing wild all over the state.

The palm-leaf miner attacks many varieties of palms, and decreases their value for decorative purposes. The larval stage of this species is the only destructive phase. The insects are gregarious, living in colonies of 35 to 100, fig. 1, *A*. As soon as the larvae hatch they spin a protective web of silk, under which the colony feeds. The fecal matter from the larvae is deposited on the upper surface of this web. As feeding proceeds further up the leaf, the web is extended to afford protection for the larvae during the feeding period. This continued feeding causes dark brown splotches upon the leaf, fig. 1, and finally causes it to dry up and die.

Both upper and lower surfaces of the leaves are subject to attack by the larvae and under forced conditions the upper surface of the leaf stems may be eaten. In heavily infested areas every frond and every leaflet upon the frond may be attacked.

Fig. 1.—Damage to palms by larvae of the palm-leaf miner, *Homaledra sabelella* Chambers. *A*, Larvae feeding on palm leaf; frass thrown back to expose insects. *B*, Webbing of two pinnae by larvae.

Food plants.—So far as is known the larvae attack trees belonging to the family *Palmaceae* only. The majority of the palms native to the United States are found in Florida, as well as a large number of intro-

duced species. Members of both types are attacked by the larvae of *Homaledra sabalella* Chambers. The first palm upon which the insect was reported was the saw-palmetto, *Serenoa serrulata* Hook. Infestation has also been reported on the following native species: *Cocos nucifera* Linn., the coconut palm; *Sabal palmetto* Lodd., commonly known as the cabbage palmetto; and *Sabal glabra* Sarg., the dwarf palmetto. Observations made by the writer indicate that the sabal palmetto is the most heavily infested native species in the state of Florida.

Many of the introduced palms are attacked by this species. Those that this insect has been found feeding upon are *Cocos australis*, which contains three subspecies that are very similar; *Phoenix canariensis* Chaub., commonly known as the Canary Island date palm; *Phoenix sylvestris* Roxbg., the wild date or India date palm; *Phoenix dactylifera* Linn., the true date palm; *Phoenix rupicola; Phoenix reclinata* Jacq., the Senegal date palm; *Latania loddigesii* Mart.; and *Washingtonia robusta* Parish. Observations made by the author indicate that *Phoenix canariensis* Chaub. is the most heavily infested of any of the palms growing in Florida.

Life history and habits.—During the course of the investigation it was found that only slight variation occurred in the length of time spent in the various stages under field and laboratory conditions.

The adult of the leaf skeletonizer is rarely found on the palms in the field. It is thought that the adults conceal themselves among the inner fronds of the palms during the day and come out at night. Those collected were usually attracted by lights at night.

Copulation and oviposition.—Copulation and oviposition undoubtedly take place at night. The adults are not very active and will not fly unless disturbed.

The preliminary steps before copulation have never been observed. However, the writer has seen numbers of individuals in the act of copulation. The male and female copulate only once during life and the length of life of the male is very short after sexual contact; usually varying from one-half day to two days. On the other hand copulation extends the life of the female. The length of life of a nonfertilized female is three to seven days. If fertilized the female has been observed to live as long as 20 days and lay two batches of eggs. The length of life of a male that does not copulate is one to four days.

In the field the eggs are deposited on the undersurface of a brownish paperlike material which when broken into pieces may be blown for considerable distances, thereby assisting in the spreading of the insect. This husk, known as the interleafing husk, separates and partially encloses the young leaflets during the early stages of growth. It is composed almost entirely of lignin and cork, being practically waterproof, and thereby affords the eggs a certain amount of protection from unfavorable weather conditions, predators and parasites. Although this husk fits fairly close to the stem it is not to be confused with the true leaf sheath. The interleafing husk surrounds the leaflets (pinnae) during the early stages of development. It is very brittle and as the leaves begin unfolding it breaks away and falls down into the center of the plant. However, some of it may remain along the stem and around the leaflets for varying lengths of time.

Several times eggs have been found attached to the bottom of a spider egg sac and also attached to the dried tips of a frond. It is believed that this is a forced condition and that the normal habit is to deposit them on the interleafing husk.

Life history.—Copulation usually takes place the day of emergence or the day after. Oviposition may also take place on the day of emergence, but this is not the general rule. The number of days between emergence and oviposition varies from 0 to 10 days. The mean numbers of days for

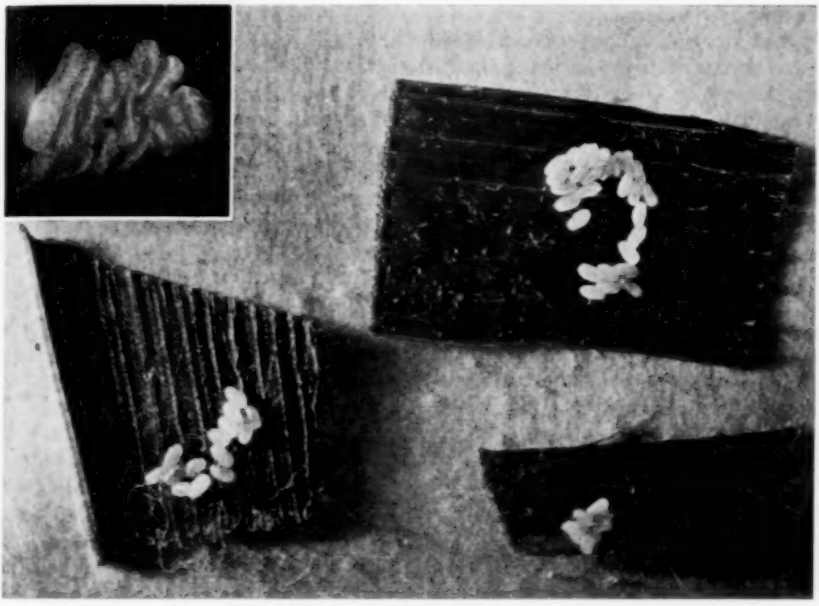

Fig. 2.—Eggs of the palm-leaf miner, *Homaledra sabalella* Chambers, laid in laboratory. *Inset*, Greatly enlarged to show characteristic markings.

the groups handled was found to be 3.1. The eggs, fig. 2, are usually deposited in agglutinated masses and attached to the leaf by a cement which is secreted by the collateral gland. The number of eggs deposited together is generally 12 to 73, with an average of 35.69. However, they are sometimes deposited singly.

Incubation period.—The number of days spent in incubation varied considerably, temperature playing a very important part in this stage of the insect's development. The minimum time required was nine days, and occurred in the summer and early fall generations. The maximum time was 25 days and occurred in January (early spring generation). Under field conditions the maximum time for incubation was found to be 47 days and the minimum 12. Development of the embryo may be readily observed, since the egg is diaphanous.

Larval stage.—When the larvae reach that point of development which enables them to emerge from the eggs, each cuts a circular hole

in the bottom of the egg shell and begins feeding immediately below the egg mass. In this way the shells afford protection for the young larvae. When they have eaten all of the leaf tissue immediately under the egg case, they spin a very delicate silken web which extends over a part of the fresh tissue. The pellets of excrement from the insects are deposited on the top of the silken covering; these eventually hide the silk and also the feeding larvae, fig. 1.

Both the upper and lower surfaces of the leaf are subject to attack,[1] fig. 1, *B*. When a leaflet (pinna) has been completely destroyed the larvae transfer to another pinna by means of a silken thread or they eat along the stem until they come to another leaf. Two or more leaflets may be drawn closely together with the aid of the silken web, fig. 1, *B*. This procedure makes the leaflets appear as though they had never been unfolded. However, the frass may always be seen extended out beyond the line of union.

Larval life consists of six definite stadia. The stadia were secured for 51 individuals.

The average lengths of time spent in the various stadia are as follows:

First	12.66 days	Fourth	6.78 days
Second	8.43 days	Fifth	5.72 days
Third	8.59 days	Sixth	11.54 days

The larva molts five times during this stage of development. Each period of ecdysis is preceded and succeeded by a short period of inactivity.

The time spent in the larval stage depends to a great extent on the season of the year in which the development is taking place. The maximum time was found to occur in the late fall or winter generation as 91 days. The minimum time occurred in the early fall generation and was found to be 29 days.

Seasonal history.—Because there is no distinct hibernating stage of this insect and the broods are continuous, the generations are not very distinct. There is considerable overlapping of generations and one may go into the field almost any time during the year and secure all stages of this insect. However, temperature plays a very important part in the length of the life cycle. If the temperature is uniformly high the time required for the life cycle will be correspondingly short and vice versa. During a very warm year there are, no doubt, one or two more generations than during a year that has a cold winter. There are usually five broods annually.

Hibernation.—This species may pass the winter in the egg, larval or pupal stage, in the Gainesville locality. Low temperatures occurring during the winter months only tend to extend the length of the instars.

Temperature studies.—All temperature tests were conducted in a *Frigidaire* at constant temperature of 32.6° F.

Thirty-three adults were tested and the average length of life was 13.27 days. The average length of life of adults, held at laboratory temperature, was 3.6 days.

[1] Comstock in "Report of the Entomologist to the Commissioner of Agriculture" for 1879 stated that they were found feeding upon only the upper surface of the leaves.

One hundred three larvae, varying from 4.8 to 9.4 mm., were subjected to *Frigidaire* conditions. The maximum length of life was 600 hours, or 9.15 days.

Forty-six pupae were subjected to *Frigidaire* conditions. The maximum length of life was 600 hours, and the minimum 24 hours. In another test it was found that the only noticeable effect that subjection had upon the length of this instar was to delay development practically the same number of days that the pupa remained at freezing temperature.

Control.—One of the best measures of control is the clean-up method. The infested fronds should be cut and burned. The common practice is to cut the leaves away and throw them in piles. This is not recommended as it has been found that the larvae in the last stadia are able to complete their development and produce imagines under these conditions. In all cases the leaves should be destroyed.

As the eggs of this species are often attached to the interleafing husk, it is advisable to remove this material and burn it.

The following are recommended as the best times for the application of clean-up measures in Florida: January 1–20, April 1–20, July 15–30, September 15–30, and November 5 to December 5. At these times the insect is usually in the last larval stadium, pupal or egg stage.

Various insecticides, both contact and stomach poisons, may be used successfully in the control of this pest. The use of lead arsenate, at the rate of $1\frac{1}{2}$ pounds to 50 gallons of water or spray material, will kill the larvae but the spray discolors the foliage and thereby detracts from the beauty of the plant. The use of lead arsenate to which has been added some material like malachite green will enable one to avoid this difficulty. As palm foliage is waxy, it is desirable to add some sticker to the spray. Rosin fish-oil soap sticker will serve this purpose.

Various proprietary pyrethrum sprays and oil emulsions were tested. It was found that several of these were toxic to the larvae; but that their penetrating power was generally poor, thereby reducing their value as a control measure.

Natural enemies.—A coleopterous predator, *Plochinous amandus* Newm., has been found extensively in the Gainesville area. The larvae of this species lives in the mines produced by the larvae of the palm-leaf skeletonizer. The inactive or pupal stage and the adult stage are also found in the same mines. The writer has never found the adults anywhere except in the tunnels made by the skeletonizer. They are very numerous in this section and no doubt aid considerably in the control of this pest. When sprays were applied to the palm leaves in an effort to control the skeletonizer, it was found that they had little or no effect upon this predaceous form.

Many forms of ants have been found to prey upon the prepupal and pupal stages. They remove these stages from the mines and devour them bodily. Colonies have been observed that have been completely exterminated by these ants.

Six hymenopterous parasites have been found preying upon this insect in Florida. They are *Cryptieropsis orbus* Say, *Apanteles* sp., *Horismenus* n. sp., *Eupelmus limneriae* How., *Bassus difficilis* Mues., and *Macrocentrus* sp.—5-10-37.

Geographical Center of Entomologists of Continental United States

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Need of definite knowledge of the center of population of organized entomologists was called to the writer's attention by A. S. Hoyt, Assistant Chief of the Bureau of Entomology and Plant Quarantine. In an effort to locate this point, a central parallel and meridian were computed by the method used by the Census Bureau (Truesdell 1933).

Residences in continental United States of members of the American Association of Economic Entomologists and of the Entomological Society

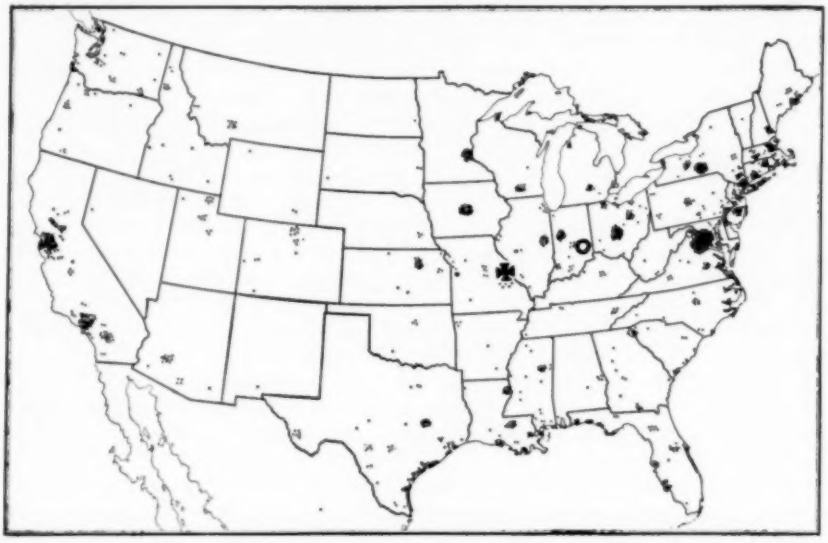

Fig. 1.—Membership of the American Association of Economic Entomologists by counties, as reported February 1936. Each dot represents a member; the cross represents the computed population center; the circle, the crossing of median lines.

of America were listed as of the beginning of 1936. The number residing in each county was written in on a county map of the United States. The necessary parallels and meridians to inclose areas 3 degrees square were drawn. The approximate lines dividing the membership into halves north and south and into halves east and west crossed near Columbus for the Entomological Society and east of Indianapolis for the Association.

The approximations used were the considering of 3 degrees of latitude to be 200 miles, 3 degrees of longitude to be 160 miles, and the population of each 3-degree area to be resident at its center. A tentative parallel was selected for a trial center, and the algebraic sum of the distances of members from this line was taken. When this sum was divided by the total number of members it furnished a correction for locating the final

line. A meridian was calculated in the same way. The point where the computed lines crossed was the center sought.

The center for the American Association was located in St. Charles county, Mo., about 30 miles west of St. Louis. The center for the Entomological Society was in Cumberland county, Ill., about 60 miles southwest of Terre Haute, Ind. The center for the two organizations combined was in Madison county, Ill., about 30 miles northeast of St. Louis. In making the last-named calculation, duplication was disregarded; a man having membership in both organizations was counted twice. It is believed that this method is equitable in determining a point for the consideration of members of both organizations. The position of the point will not vary much whether duplication is disregarded or not.—4-23-37.

Literature Cited

Truesdell, L. E. 1933. Urban and rural population, metropolitan districts, and center of population. Rept. 15th Census U. S. 2:6–21.

SECTION OF PLANT QUARANTINE AND INSPECTION

Accomplishments of the Bureau of Entomology and Plant Quarantine under Emergency Funds

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Any consideration of the accomplishments under the direction of the Bureau of Entomology and Plant Quarantine resulting from the use of emergency funds should be prefaced by an expression of appreciation to those who have made available the various allotments of emergency funds for this purpose. The Bureau has accepted these allotments in the belief that there was useful work to which they could be devoted which would afford employment and accomplish definite results in plant pest control in the United States. It is with pleasure, therefore, that advantage is taken of this opportunity to record some of the results which have been obtained through the use of these allotments of emergency funds for plant pest control work.

It should also be recorded that good work has been done by the men referred from relief rolls to the various projects of the Bureau. These men generally have proved themselves to be industrious, willing and capable to a degree that was not anticipated and opportunity is gladly taken, therefore, at this time to express appreciation.

Appropriation.—From June 1, 1935, to December 31, 1936, allocations by the Works Progress Administration to the Bureau of Entomology and Plant Quarantine for work relief projects for insect or plant disease eradication or control have amounted to 22 million dollars. On December 31, 1936, 21 million dollars had been expended or obligated.

Program.—Forty million man-hours of employment have been provided in 1592 counties throughout 44 states. On December 31, 1936, 16,000 workers were being employed; and at the peak of the work 27,725 workers were employed. The average over-all cost has been $73 per worker per month. Ninety per cent of the workers have been taken from relief rolls and 10 per cent from non-relief rolls. Of every average relief appropriation dollar, 80 cents has been spent for wages and salaries and 20 cents for miscellaneous operating expenses.

These activities were concerned with the eradication or control of plant pests, including the following: gypsy moth control, brown-tail moth control, Dutch elm disease eradication, barberry eradication, white pine blister rust control, citrus canker eradication, phony peach disease control, scouting to determine distribution of the European corn borer, eradication of wild cotton in Florida for protection against the pink bollworm, destruction of Thurberia plants in southeastern Arizona as an aid in the control of the Thurberia weevil, and eradication of peach mosaic.

Results.—Some of the outstanding results achieved follow.

Gypsy Moth Control.—Scouted 1,875,401 acres; treated 5,493,252 egg clusters; thinned 13,267 woodland acres; cut 25,410 trees; burlapped 2,957,127 trees; crushed 16,612,418 larvae; crushed 504,290 pupae; sprayed 134,743 tress; sprayed 16,785 acres of woodland,; sprayed 216 infestations.

Brown-tail Moth Control.—Removed 391,703 trees from 1356 acres; scouted 3,161,780 acres; examined 15,212,648 trees; cut 4,672,175 webs.

Thurberia Plant Destruction.—Worked 157,390 acres in Tortollita and Santa Catalina mountains; 971,873 plants destroyed; worked 147 miles of roads; worked 21 miles of trails.

Wild Cotton Eradication in Florida.—Cleared 5051 acres; removed 123,000 plants and 2,900,000 seedlings; Scouted 164,000 acres in addition to clean-up.

European Corn Borer Survey.—Examined 5817 fields; surveyed 32,600 acres.

Dutch Elm Disease Eradication.—Sampled 50,729 trees and confirmed the presence of the disease in 7407. The program for removal of dead and dying elms in the infected area resulted in the destruction of 825,000 upland and 386,000 swamp elms. These trees are not known to be diseased but presence of dead and dying wood in them makes them attractive to elm bark beetles and particularly likely, therefore, to become infected.

White Pine Blister Rust Control.—Covered 4,481,388 acres; eradicated 230,841,973 ribes and destroyed 60,585 fatally infected pines.

Barberry Eradication.—Area covered, 76,000 square miles, involving 83,000 properties. Removed 34 million barberry bushes.

Citrus Canker Eradication.—Destroyed 12,556,861 diseased trees.

Phony Peach Disease Control.—Destroyed 49,344,604 diseased peach trees.

Peach Mosaic Control.—Destroyed 98,136 diseased peach trees.—1-27-37.

Origin and Development of the Canadian Plant Inspection Service

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Legislation relating to the control of insects and plant diseases has increased markedly in recent years, not only nationally, in many countries of the world, but internationally as well. In Canada there has been no exception to this increasing necessity to protect national products. The nature of the products so affected has extended gradually from plants and purely agricultural crops to the present day scope of both the growing and harvested crop; the finished product, the forests, and incidentally the many enterprises associated with the final disposition of all such products have been affected. As the years advance new and even more serious anxieties seem to arise requiring further and more intensive efforts to prevent pest introduction or control. Assuredly, modern trade activities have placed the entomologist and the plant pathologist on a solid footing in their relations with the public, but with accumulating and more difficult responsibilities.

Insect legislation in Canada did not originate with the present generation of entomologists and it may be assumed that entomologists can take no credit for its origin. In 1933, R. P. Gorham of this department reviewed all insect and plant disease legislation which had been enacted in the provinces of Canada and by the Dominion Parliament. This summary contains many interesting records. The first legislation was an "Act for the Preservation of Apple Trees in the Parish of Montreal" passed on March 25, 1805, and apparently was designed to check ravages by a caterpillar which we may assume was the canker worm. The preamble explained that

> the ravages of the insect could be materially checked and the numbers thereof diminished by tying in the spring, about the trunk of each tree, a bandage, and smearing the same repeatedly with tar to present an obstacle to theprogress of such insect from the ground to the branches [and] whereas the labour of industrious persons, who employ the said means to protect their trees may be rendered endless and in great measure useless by the indolence and negligence of their neighbours, who leave their trees to be overrun with these insects, whereby they are annually propagated and again extended to the trees of the industrious.

The act follows, requiring owners of trees to keep the tar on their bandages in a sticky condition by renewing it four times in the spring and similar treatment in the autumn. A penalty of a fine per untreated tree varying from 5 shillings to £5 was provided and fines were shared equally by His Majesty and the informer. The duration of this legislation was set at three years, but it was renewed and expired in 1812. The next activity was in 1829, in the "Laws of Lower Canada" when an act was passed "For the More Speedy Remedy of Divers Abuses Prejudicial to Agricultural Improvement." Its provisions were not as specific as the preceding reference insofar as insects and diseases were affected. The next record is of special interest; in 1871, the "Agricultural and Arts Act" Ontario was amended to provide for the incorporation of The

Entomological Society of Ontario, previously known as the Entomological Society of Canada. The society's officers in those days undoubtedly realized the advantages of governmental recognition as there were certain definite benefits associated with the change of name and status. Incidentally, this entomological organization is still regarded as the national society in Canada and has continued to develop in usefulness to fellow workers as well as service to the public. Its seventy-fifth anniversary will be celebrated in 1938.

The province of Prince Edward Island provided legislation in 1883, entitled, "An Act to Prevent the Spread of the Potato Bug" and in 1895, an "Act to Prevent the Spread of Black Knot on Plum and Cherry Trees." Nova Scotia's first pest legislation was in 1898, dealing with control of the San José scale. That act was repealed in 1911, and was replaced by an "Act to Prevent the Introduction and Spread of Insects, Pests and Plant Diseases Destructive to Vegetation." With certain amendments it is still in force. New Brunswick passed a somewhat similar act in 1913. The province of Quebec passed an act in 1895, "Respecting Abuses Prejudicial to Agriculture" which was incorporated in the municipal code in 1903, and in 1914 an act was passed with the short title of "The Plant Protection Act," which covered precautions concerning importations from other provinces as well as control within the province. In Ontario several acts were passed, amended and repealed between 1897 and 1910, when the legislation in force at the present time was passed, with certain amendments during that period. In 1925, a separate act relating to the control of the European corn borer was enacted. Manitoba's first legislation occurred in 1919—"The Municipal Act" and in 1927 an "Act to Prevent the Introduction and Spread of Insect Pests and Plant Diseases" was passed which is still in force. Saskatchewan took no action concerning insect legislation until 1920, when provision was made for the control of grasshoppers. In 1922 Alberta found it necessary to pass an "Act to Provide for the Extermination of Agricultural Pests."

The province of British Columbia has been specially active in providing legislation to protect the agricultural and horticultural industries. Although a Ministry of Agriculture was provided in 1873, the first record of provision for an inspector of insect pests was in 1892. From then on the scope of pest and disease legislation increased under the "Agricultural Associations Act" with such thoroughness from the viewpoint of protection, not only from the provincial standpoint, but nationally, as applying to importations from abroad, that during the period 1919 to 1932 the British Columbia inspection staff was entrusted with the responsibility of examining all importations affected by Dominion legislation which entered that province.

National legislation in Canada affecting insects and plant diseases is of comparatively recent origin. In 1898 there was passed an "Act to Protect Canada Against the Introduction of the Insect Pest Known as the San José Scale." This was the Dominion's first restriction on the importation of plant material into Canada. It prohibited the importation of the host plants from countries in which scale occurred. After three years the act was amended to allow such importations subject to fumi-

gation with hydrocyanic acid gas, at one of six fumigation stations maintained at different points, and importations were limited to the spring and fall seasons.

The first organization by the Dominion Department of Agriculture regarding the inspection of foreign nursery stock entering Canada, was a cooperative arrangement made in 1909 by the present Dominion Entomologist, with nurserymen in the provinces of Ontario and Quebec. This action was the result of finding nests of the brown-tail moth on importations of fruit seedlings from France, and the work conducted that season, when 196 nests containing living larvae were found, emphasized the importance of providing greater protection against the introduction of pests of foreign origin. In view of the absence of any legislation, other than the scale act referred to, either to safeguard from introductions or to control pests within Canada, the present Dominion "Destructive Insect and Pest Act" was passed in May 1910, and the San José scale act was repealed. The provisions of the new act were wide and were constructed with such care that those who were associated with its preparation may assume full satisfaction in the knowledge that no major changes have been necessary, with the exception that in 1932 and in 1934 amendments were made to provide for the inspection of exports and to clarify the act in relation to provincial jurisdiction.

The preceding review will indicate that although insect legislation existed in Canada as early as 1805, serious provincial and Dominion concern has been limited, with the exception of British Columbia, to the period since 1898. In view of the many introduced insects which are responsible for various losses, it is evident that control over importations could have been provided much earlier to definite advantage. In 1912 the late Dr. C. Gordon Hewitt who as Dominion Entomologist was so closely connected with the preparation of Canada's present act, in discussing the discovery of various species of living insects intercepted on imported stock, said "that this work has begun none too soon and that the expense incurred in carrying on this work is trifling compared with the actual value of the protection which it insures."

The act provided for the Governor General in Council to make such regulations as are deemed expedient to prevent the introduction or admission into Canada or spreading therein of any insect, pest or disease, destructive to vegetation. Accordingly, no time was lost in passing regulations to meet immediate needs. A summary of the more important legislation passed during the first two and a half years following enactment of the act is:

> Nursery stock for propagating purposes was required to be routed through one of six ports for fumigation, as applying to stock of other than European origin, while stock from Japan or the New England states required inspection in addition to fumigation. European shipments were subjected to inspection only and three additional ports were established for the entry of such stock. Greenhouse grown plants of a special nature, herbaceous perennials and herbaceous bedding plants, bulbs, tubers, etc., were exempted from restriction. A list of destructive insects, pests and diseases, the presence of which on importations or in outbreak form in Canada would involve entry refusal or treatment was given and the responsibility of importers or property owners was stipulated. Compensation not exceeding two-thirds of the value of any material destroyed was provided for. Other regulations passed during the same

period prohibited the importation of potatoes from Europe, Newfoundland or the Islands of St. Pierre and Miquelon; chestnut and chinquapin were prohibited from the United States and conifers were prohibited from the New England states while certificates covering freedom from the gypsy moth were required in the case of forest products from the same area. A further prohibition pertained to non-canned fruits, plants, etc., from the Hawaiian islands.

The organization under which the above inspection and fumigation procedure was carried out required the importer to advise the Dominion Entomologist of the details of his proposed importation, and again on arrival of the stock the customs officials were required to cooperate by refusing delivery unless the shipment had been fumigated or inspected, or arrangements made for inspection after delivery, and to return to the country of origin or destroy any prohibited importations. This procedure was undoubtedly appropriate for several years and as the staff under the direction of the Dominion Entomologist was very limited the necessity for soliciting this extensive cooperation of customs officials in keeping a check of importations can be realized. Insofar as the actual inspection work was concerned it is desired to record the fact that in Canada during those early years almost the entire technical staff had to be transferred to plant inspection work during the importing seasons. The present Dominion Entomologist, Dr. Arthur Gibson, played an important part in organizing and carrying out inspection activities which included the cooperation of provincial entomologists. In brief, the "Destructive Insect and Pest Act" and its regulations may be regarded as the foundation on which much of the entomological work of the Dominion Department of Agriculture, since 1910, has been built up to its present extensive activity.

With the increase in nursery stock importations and resulting inspection work a Division of the Entomological Branch was established in 1919, under the direction of L. S. McLaine. By 1920 it was realized that the scope of inspection work was necessarily extending to such a variety of products and was associated so definitely with trade that consideration was given to a general reorganization of administration. Early in 1922 the Destructive Insect and Pest Act Advisory Board was constituted, the personnel of which comprises the Dominion Entomologist, chairman, director of Experimental Farms, vice chairman, the Deputy Minister of Agriculture, the Dominion Botanist and the Chief, Division of Foreign Pests Suppression, secretary. The board is not empowered to pass legislation, but may recommend to the Minister of Agriculture any changes in the regulations under the act which are considered advisable and in the public interest, and may call upon others to act in an advisory capacity. The actual administration of the regulations is the responsibility of the Branch concerned, as applying to insects or plant diseases.

Following the appointment of the board, consideration was given to existing legislation and requirements with the result that following a public hearing, the arrangement of the regulations was changed, effective September 1, 1923, whereby the importing procedure was revised, and new regulations added. These changes involved principally the following: Discontinuance of a list of insects and diseases affected by the act; under general regulations provision for dealing with any pest or disease

as applying to importations; the establishment of a special regulation governing the importation of nursery stock, (a separate one as applying to the United States which was rescinded later); the enactment of separate regulations (foreign), as applying to the importation of specific plants or products from various countries, due to prohibition or restriction; and, under a series of domestic regulations, quarantine legislation was provided for the control of regional outbreaks of foreign pests within Canada. The new regulation, applying to the importation of nursery stock, included bulbs, tubers, perennials, etc., which were not affected by the previous legislation.

The action referred to (1923) represents the second important major activity in the organization of the plant inspection service in Canada. By that legislation the authorized importing season was extended to the entire year, new ports of importation were opened and staff was increased accordingly. The inclusion of bulbs, etc., under the importing procedure resulted in an opportunity to assign specialists to the study of bulb diseases which has resulted in much valuable information and, incidentally, a marked improvement in the quality being shipped to Canada. In general, miscellaneous nursery stock received in Canada has increased in quality and general freedom from pests accordingly.

Legislation in force for some years has dealt with plants or plant products infested with insect pests or diseases. Restrictions on the importation of living insects or plant diseases, was, of course, inferred. However, to bring this matter more forcefully to the attention of customs officials and others concerned, a special regulation was passed in 1934 requiring a permit for each importation of this nature. Naturally, the greatest care is taken in issuing such permits.

Full information relating to the "Destructive Insect and Pest Act" and regulations thereunder, as at present in force, is available through the Dominion Entomologist or the secretary, Destructive Insect and Pest Act Advisory Board, Ottawa. In this paper a brief summary of the inspection procedure as applying to importations may be of interest as follows:

NURSERY STOCK

(1) The importer must apply to the Secretary of the "Board" at Ottawa for a permit to cover each importation, giving the kinds and quantities of stock being ordered (by species and varieties except in the case of bulbs, tubers, roots, etc.) and the names and addresses of both importer and shipper.The permit must be retained to present with the other clearance papers to the Canadian customs and the importer is required to advise the shipper of the permit number. In case any prohibited item is included on the application for permit the importer is instructed to cancel the item. A copy of each permit issued is supplied to each port of importation.

(2) The shipper is required to (a) have the stock inspected within a reasonable period of the date of shipment and satisfactorily certified, the original certificate accompanying the shipping papers and available to the Canadian inspector at the port of importation in Canada and a copy certificate attached to each container ("blanket certificates" covering field inspection and valid for lengthy periods are not acceptable); (b) mark each container with the permit number issued to Canadian importer; and (c) routé the shipment via one of the Canadian ports of importation. All importations are subject to reinspection in Canada and to comparison of contents with permit authority.

(3) On arrival at a port of importation the transportation company must hold the consignment for the attention of the inspection staff. If everything is in

order as applying to the permit and the certificate from the country of origin, the consignment is dealt with promptly either by inspection and issuing an inspection certificate authorizing the customs to release on presentation of the permit or, by issuing a clearance certificate, authorizing release to the consignee for inspection after delivery to his premises, in cases where an inspector is located at or near destination of the shipment.

(4) To facilitate deliveries provision is made for the district inspector to issue an emergency permit at the port of importation in cases where a standard permit has not been procured and if he is convinced that special circumstances exist.

(5) The same procedure applies to parcel post importations except that a special mailing label is issued with the permit on request for transmittal by the importer to the shipper to attach to the package. In issuing the labels at Ottawa, the nearest or most direct port of importation to destination is selected. The label directs the package in care of the inspector and after examination it is re-forwarded to the consignee without additional postage.

(6) All costs, other than the services of an inspector, are the responsibility of the importer and all importations are at his risk.

PLANT PRODUCTS

Permits are not required for the importation of plant products, such as fruits, vegetables, grain, nuts, seeds, etc. However, under the "General Regulations" of the act, authority is provided to inspect any commodity and if found infested with any pest or disease to take any remedial action considered necessary. Products known to represent an actual danger in introducing pests are prohibited entry or restricted. Miscellaneous importations are inspected insofar as staff and time will permit, special attention being given to products causing anxiety.

Action resulting from the discovery of insects or diseases on importations depends upon the importance of the interception as a potential pest, the degree of infestation or infection, and the possibility of satisfactory treatment. Affected importations may be refused entry and either destroyed or returned to the shipper, at the option of the responsible party, in such cases the possibility of danger being taken into consideration; sorted subject to reinspection with destruction of affected plants (applying particularly to bulbs, etc.); treated by fumigation or other agency or released under quarantine for further observation. The Dominion Botanist and his staff cooperate in regard to plant disease interceptions.

Samples of all interceptions are submitted to headquarters at Ottawa for confirmation or original identification. In cases where serious action is involved the opinion of the specialist concerned is obtained before the consignment is finally dealt with. Individual interception reports are maintained for each affected importation and the importer receives a full report concerning any action taken in dealing with his importation, which document is available for any adjustments with the shipper or Canadian customs.

The information contained in this paper has been restricted mainly to the plant inspection service as applying to importations of plants and plant products. It may be pointed out, however, that considerable inspection work is entailed in the enforcement of domestic quarantines which have been established in an effort to prevent the movement of host plants infested by foreign pests which have become established in restricted areas of the Dominion, or to eradicate incipient outbreaks of certain species as they occur. Probably the most important result of the

reorganization regarding the inspection of importations is due to the fact that a special staff is enabled to devote its entire time to inspection activities and associated investigations, thus increasing their knowledge and efficiency through experience. In this connection, the inspection staff, although established at definite headquarters at the several points throughout Canada, has been assigned a geographical district in each case. This policy has developed a personal interest and responsibility in maintaining a high standard of inspection in the respective districts. The staff is trained to be continually on the alert for outbreaks of interest and in many cases have served as individual investigators or as general field assistants to those engaged in both economic and biological control studies.

Inspection of both plants and plant products for export to various countries of the world is also a duty of the inspection staff. This work has been increasing steadily in recent years, due not only to an increase in the quantity of plants being exported, but to the general world wide activity in establishing inspection requirements in the country of origin for importations of plants or plant products. The contacts which must be maintained to keep informed of such legislation and the summarizing and distribution of the information to the parties concerned with exports from Canada is a task of considerable scope.

Relative to the scope of this work, we have summarized to date plant legislation of 219 countries (including territorial possessions) affecting the export from Canada of plants and certain plant products to 107 empire and 112 non-empire countries. The products concerned, for the most part, are apples, fruits and vegetables (other than apples and potatoes), nursery stock and plants, potatoes, and seeds.

For example, there are 81 countries (26 empire and 55 non-empire) which require an accompanying certificate of health with shipments of apples; 75 countries (23 empire and 52 non-empire) requiring certification for vegetables, and 120 countries (39 empire and 81 non-empire) requiring certification for potatoes. As far as nursery stock is concerned, it is our established practice to inspect and certify all consignments to all countries.

Regarding export certificate forms, there are at present a total of 72 in use; 22 of which include the main covering types for all countries, and 50 bearing subnumbers for countries requiring special forms for different products. In other words there are 21 specially drafted types for as many countries, not including their subnumbers, besides our standard health form which is very similar to the uniform certificate suggested at the Imperial Mycological Conference held in London, England, a few years ago for use throughout the British Empire.

It is our policy to reduce the number of certificate forms as much as possible and whenever possible, with the advantage of uniformity in mind. In that connection it may be pointed out that 198 of the world countries concerned now accept our standard form with, in some cases, necessary additional riders, for miscellaneous products.

Concerning the matter of export certification, all will agree that any country is fully justified in protecting its agricultural and horticultural interests in the manner under discussion, but it would seem both desirable and practicable that steps already advanced to establish a uniform

certificate of health acceptable to all countries, possibly with special declarations in certain cases, should be concluded with the least possible delay. By that action inspection requirements associated with international trade would be simplified appreciably.

In considering the future of inspection services such as that being dealt with, it is recognized that no inspector or group of inspectors can guarantee large quantities of material as absolutely free from pests or diseases as a result of "eye" examination; consequently, regardless of the reputation of the service in the country of origin, reinspection on arrival is considered advisable. But who can foresee possible changes in the procedure to be followed in later years. Restrictive or prohibitive legislation is based, presumably in all countries, on biological facts. To facilitate international or even national trade, it may occur that developments in the wholesale treatment of products to remove the anxiety of possible danger will have a marked effect. Definite progress has been made in the development of satisfactory sterilization treatment as applying to insects, advanced results may be expected in the near future and even electricity may eventually supplant the inspector's eye as a final national safeguard. In the meantime we must do our best to prevent the transportation of injurious pests and diseases from one area or country to another.—5-17-37.

Status of Potato Wart Control in Pennsylvania

R. H. Bell, *Pennsylvania Department of Agriculture, Harrisburg*

Potato wart disease was first found in Pennsylvania near Hazleton in the fall of 1918. An intensive survey was immediately undertaken by the state and federal Departments of Agriculture, special attention being given to villages and towns throughout our coal-mining districts into which it was known large shipments of European potatoes had been made following the short-crop season of 1912.

During the fall of 1918, 250 infected gardens were located; in 1919, 377 and by the end of 1922 the number had reached 813 infected premises. From 1923 to 1927 little survey work was carried on but since then attention has been given more or less regularly to the checking of suspected areas with the result that up to and including 1935, 64 additional diseased gardens were found, making a total of 877 located in 12 counties but mostly in Luzerne and Cambria. Conditions surrounding all of these finds are remarkably similar, constituting small mining towns located on high elevations (1600 to 2000 feet) in nonagricultural areas and effectively isolated by woodland, distance or other natural barriers. Fortunately, potato culture is strictly on a home-consumption basis in all of these communities, there being no surplus crop to seek outside markets. Fortunately, also, with one or two exceptions, these infected areas are far removed from sections where potatoes are produced on a commercial scale.

During 1936 three additional warted areas were located; two of these comprising one garden each are immediately adjacent to regulated territory. The third is more distant but all are situated in the same type of territory as is common to previously found infections. In one case the land had been in grass for at least 10 years previous to the planting of potatoes in 1936 and in the third case, which is the most extensive of the three, residents relate that potato culture was practically abandoned in the community about 1918 because of wart but the condition was not reported to anyone having an interest in such matters. Finally, during 1933, relief garden activity revived interest in growing potatoes with the result that wart again appeared and, again, was not reported until we happened on it more or less accidentally in 1936.

This explanation seems to check closely with our survey records during the 1918–1920 period and later, which show less than a half-dozen potato growers in the neighborhood. Hence there was a very inadequate basis upon which to determine the presence of wart and consequently it is not surprising that the disease was not located by surveys made during this period of light planting. Our conclusion, therefore, is that all three of these 1936 cases are original infections and do not indicate spread from other Pennsylvania areas. In fact, we have yet to find a case that indicates spread beyond the quarantine line.

Incidentally, this third 1936 case seems to give us an indication of the rapidity with which wart is revived after years of quiescence. Local growers state that their 1933 crop was fair, the 1934 crop poorer and that of 1936 practically a failure. In other words, after four years of renewed planting, conditions had apparently reverted to the status of 1918 when potato growing had been practically abandoned.

Quarantine.—Since quarantine and its relation to potato wart will be discussed in another paper, I shall take time only to point out certain features of policy which we have recognized in Pennsylvania from the beginning. We believe that under the circumstances, maintenance of a quarantine is the only safe procedure for the following reasons: (1) While potato wart may not spread as rapidly and freely as most plant diseases do, yet it does spread, otherwise it would not be found in this country. (2) More than 90 per cent of our potato crop consists of susceptible varieties. Shifting to immune varieties, even if available, would mean seed certification and inspection on a state-wide basis, which would cost as much, if not more, than the maintenance of a quarantine. (3) With wart let loose in our potato districts, land values would certainly suffer in addition to direct losses to the potato crop. (4) In the absence of regulatory action on our part, we could reasonably expect that other states would place restrictions against us in order to protect themselves. This would be a serious handicap to our growers and shippers. (5) Since our investigational work favorably points toward a satisfactory method of eradication, we are hopeful that in time we can get rid of both potato wart and the quarantine.

Wart eradication.—From the beginning, investigational work has been an important phase of our wart control program. The relationship of soil temperature to wart development; effect of various cultural practices on soil infection; correlation between soil moisture and wart de-

velopment; tendency of tomatoes to perpetuate soil infection and whether there are immune varieties of tomatoes; testing (planting to susceptibles) of gardens known to be infected to determine the longevity of wart under field conditions; development of an effective and practical method of soil sterilization and various other aspects of the problem have been given attention. Many points of interest have been developed by these studies but I shall mention only three.

Effect of Soil Temperature on Wart Development.—Through the use of automatically controlled temperature equipment and after repeated trials, the point has apparently been established that there is a definite relationship between soil temperature and wart development, the optimum being somewhere in the neighborhood of 60° F and the upper limits or deadline 70° F. That is to say, even though wart is abundantly present in the soil it does not develop if the soil temperature remains above 70° F for any length of time during the critical growing period from June to September. A point of interest in this connection is that wart in Pennsylvania has been found only at high elevations (1600 to 2000 feet) where soil temperatures do not remain above 70° F for more than a day or two at a time during the growing season. And even in these locations infection has been normal (heavy) or absent depending upon whether the season has been normal or dry and unusually hot. On the other hand, wart has not been found in the lower sections of Pennsylvania where we find soil temperatures commonly ranging considerably above 70° F for a good portion of the growing season.

Planting of Infected Gardens.—Test planting of infected gardens using susceptible varieties of potatoes has been an annual practice with us for a number of years and we now know that when such gardens are so planted they will under favorable conditions develop wart even after a lapse of 17 years between potato crops. From this it would appear that the idea of starving out wart cannot be depended on as a positive means of eradication notwithstanding the fact that such infections, in our experience, have always been very light. Apparently confirming this observation, tests conducted under controlled conditions also indicate that the degree of infection does decline in the absence of favored host plants.

Soil Sterilization.—The third point I wish to discuss, one which has prominently come to the front as a result of our investigational work, is that of soil sterilization. Treatment of soil has long been recognized and studied as an important means of attacking the problem of potato wart control. During the progress of our investigations several materials and methods have come to light which are effective controls but in all cases except one they have proven impracticable because of excessive cost, residual effect on the soil or for other reasons. The one exception is the chemical ammonium sulfocyanate which was originally developed as a herbicide for the control of weeds.

We first tried this material in 1932 and it proved very effective when used under controlled conditions. The next year (1933) the experiment was extended to include an infected garden in one of our outlying areas. This garden was treated early in April and planted to susceptible Rurals in late June. The results being satisfactory, 11 additional gardens, also in outlying areas, were treated in the fall of 1933 and all 12 were planted

to susceptible potatoes in the spring of 1934. In one of the newly treated gardens comprising 5850 square feet, one potato plant developed wart. In a second garden of 12,720 square feet wart was found in one small area. In both cases heavy sods which could not be thoroughly broken previous to treatment, excessive soil moisture or rubbish mixed with the soil interfered with a thorough job of treatment. Both of these infected spots were immediately re-treated and all 12 gardens were again planted to susceptibles in 1935 and all showed complete freedom from wart in the crop produced that season.

Two additional gardens were treated and test planted in 1935 with equally favorable results, and in the spring of 1936, 16 additional treatments were applied. All of these later treatments and 11 of the 12 gardens previously treated—a total of 29—produced wart-free crops during the

Table 1.—Five-year schedule of experimental soil treatment to control potato wart in Pennsylvania.

	Treatment				
	First Year	Second Year	Third Year	Fourth Year	Fifth Year
Application of chemical	x				
Plant susceptible potatoes	x	x	x	x	x
Inspection at digging time	x	x	x	x	x
Plant-by-plant inspection*	x	x	x	x	x

* Spot treatment if necessary.

season of 1936. The single garden in which one plant developed wart in 1936 is one of the two in which a few warted plants were found in 1934. This particular spot comprises a spring of water, not free flowing but sufficient to maintain an excessively moist soil condition which apparently interferes with the action of the sterilizing agent. This small area has been re-treated with a double dosage in the hope that the adverse soil condition may be overcome. Our plans for 1937 call for the treatment of 16 additional gardens, thus making a total of 46 in 17 communities out of the 116 gardens in 34 outlying areas.

From the beginning of our soil sterilization program we have recognized the fact that the eradication of a disease, especially if it is soil borne, is a vastly more exacting or stubborn proposition than mere control of the same disease. In the latter case we seek to reduce losses to a practical minimum while in the former the object and aim is to get rid of every last vestige of the pest. Hence eradication of potato wart is by no means as simple as it may appear on the surface. It does not consist simply in applying 2000 pounds per acre of a given chemical to a plot of ground, then passing on to the next plot with the assurance that the job is finished so far as the first plot is concerned.

In the absence of any precedent to guide us we started the eradication work with the idea of following each treatment through a five-year period. That is to say, we set up a schedule for each case, approximately as in table 1.

In conjunction with this schedule our quarantine is modified in each instance to permit planting (under permit) in other gardens throughout

the community any variety the grower may choose. These plantings are all checked each of the five years by field and digging inspections as a means of locating any infections not uncovered by previous surveys. Areas which come through this test without a recurrence of wart will be considered free of the disease and will be dropped from the quarantine.

As time goes on and we gain experience in the eradication work it may be found advisable to change our present plan of procedure. For example we may try out the idea of test planting gardens previous to treatment and in this way possibly eliminate part of the cost of chemical and certain other items. The five-year period of checking should however operate in this case the same as where actual treatment is applied. The thought here would be to take advantage of the possibility that under some conditions the starving-out process may function. If this assumption should prove correct in an appreciable number of cases, it would materially reduce the cost of eradication and proportionately improve the chances of ultimate success.

We are very much encouraged by the continued favorable results secured in this work. It is our feeling, however, that the eradication program has not passed entirely beyond the experimental stage since, so far as we know, this is the first serious attempt in this country to eradicate a soil-borne plant disease on a field basis.—5-17-37.

Important Features of Nursery Inspection

G. M. Bentley, *State Entomologist, Knoxville, Tenn.*

In addition to the methods generally in use in making nursery inspections there are three features which in my opinion should be given consideration.

Billing yard inspection.—First is the billing yard inspection of all types of nursery stock. The usual practice with the nurserymen is to run the digger about the middle of October, when the stocks are pulled and sorted. Worthless ones are culled and stock which is desirable in the eyes of the nursery hands is carried to the billing yard to be heeled in trenches, each variety being marked. A few states have their inspectors present to examine carefully roots and tops, attention being directed to woolly aphis knots, nematode enlargements, crown gall and borer injuries on roots and blotch, blight or scale insects on body or branches. All the nursery stock to be sold before the next growing season inspection has by this method been inspected and this inspection following the growing season inspection of the stock is to look primarily for San José scale in the nursery and the environs for scale and phony peach disease where peaches are grown.

One cannot help feeling that the billing yard inspection is really the more important of the two although both inspections are necessary. A few states are making the billing yard inspection. It should be a uniform practice in every state.

Variety record and invoice.—Second, increasing correspondence has come to the office stating that purchases from nurserymen would be made if information could be furnished as to the source of the grafting material and bud sticks. Realizing that the gathering of this data might be just a little beyond or outside of the functions of a nursery inspector, many leading nurserymen were consulted to learn whether they could supply such information and if they would be willing to furnish it. In every case they could give it and would be glad to do so.

For the first time in Tennessee these data were collected this year and the inspectors gladly cooperated. The variety record sheets for each nursery are attached to the regular inspection form. A practice of this kind will cause nurserymen to require resources from which propagating material is secured to label varieties more carefully.

As to invoice of varieties of nursery stocks, such data are valuable and have been compiled annually for several years in Tennessee. This information shows a shortage of certain growths, or on the other hand an abundance of certain varieties. Thus nurserymen may avoid getting too much of one variety or too little of another. The nurserymen want just this information and when the nurserymen obtain from the inspector's office the information they want, it works to an advantage. We find that better cooperation can be expected from them. I am offering the variety record as a feature in nursery inspection service, and I shall be glad to have comments for or against such a practice.

Highway truck inspections.—Third, the subject of truck distribution of nursery stock without certificate tags has been for some time a matter which has bothered the inspection officials. To keep men on the highways to inspect trucks conveying loads of nursery stock is expensive. A suggestion to aid in this problem would be to obtain cooperation of the state highway patrol. It would be of small inconvenience for them and upon finding trucks conveying nursery stock not carrying out the regulations same could be cited or the license plate recorded and phoned to the entomologist's office. Interceptions and penalties published in papers would soon put a stop to the large amount of this irregularity.

These three features of the nursery inspection service are given, thinking that in the standardized of the nursery inspection they might be considered and might form a part.—5-19-37.

Progress of Japanese Beetle Suppression in St. Louis

J. Carl Dawson, *Missouri Department of Agriculture, Jefferson City*

Results of the 1936 season's trapping work have shown the Japanese beetle suppression activities in St. Louis to have been quite successful thus far. Trap collections in the original infested area, where 1351 beetles were taken in 1934, have been reduced to 14 beetles in 1936, which is a reduction of approximately 99 per cent. The total trap collection for the entire city has been reduced to 88 beetles, which is a 93.5

per cent reduction. Although there has not been sufficient work of this type carried on in the past to enable a prediction of the future outcome of the St. Louis work, it is hoped that the favorable results of this season may be some indication of even better future results and that eradication of isolated Japanese beetle infestations may be possible.

In 1934, when the beetle was first discovered in St. Louis, 2600 old-type traps then in operation captured 1351 Japanese beetles, in a more or less contiguous area of about 1200 acres. Unfortunately, the last 1000 of these traps did not arrive until the middle of July, when the beetle season was about half over. An attempt was made to cover the entire city by frequently moving the traps from place to place. The larger

Table 1.—Results of three years' work on Japanese beetle suppression in St. Louis.

Year	Approx. No. Traps in Operation	No. Beetles Collected in Areas Treated in			
		1934	1935	1936	1934–1936
1934	2600	1351			1351
1935	10000	904	328		1232
1936	14000	14	59	15	88
		Per Cent Reduction of Infestation			
1934–1936		98.96			93.48
1935–1936			82.01		

supply of traps in operation in 1935 indicated that the 2600 traps operated in 1934 were inadequate.

Arsenate of lead soil treating work in the 1934 season was carried on between September 26 and November 8, during which time about 225 tons of arsenate of lead were applied to 450 exposed soil acres, at the rate of 1000 pounds per acre. This represented a total city area of about 1350 acres or 235 city blocks. Considerable difficulty was experienced in obtaining necessary funds for this treating work, and it was feared that the application was made too late in the season to be very effective in killing the grubs then in the soil.

For the 1935 season, the 2600 old-type traps, equipped for bran mash bait, were replaced with 10,000 more efficient new-type traps in which the bait container was located in the center of the baffle. It was possible with this more adequate supply of traps to place at least one in every block in the city of St. Louis that was favorable to the beetle, and to make heavy concentrations in infested areas. This resulted in the capture of 1232 beetles, 904 of which came from the area that had been found infested and was treated the previous year. Of the remaining 328 beetles taken in newly infested territory, 178 and 101 respectively were from two new centers of infestation, one of which was adjacent to the 1934 treated area and the other about a mile to the north. These trapping results showed a one-third reduction in the area treated the previous year, which was responsible for a reduction of 119 beetles in trap collections for the entire city.

Between August 8 and September 7, 31½ tons of arsenate of lead were applied to 63 exposed soil acres, which included all of the more im-

portant infested blocks. Between September 26 and October 8, an additional 17 tons of arsenate of lead were applied to 33.8 exposed soil acres, in an effort to cover thoroughly all of the newly infested blocks and to include a reasonable margin of safety.

Summarizing the treating work of both the 1934 and the 1935 seasons, it is found that a total of 273 tons of arsenate of lead were applied to 547 exposed soil acres in a total city area of 1640 acres, or about 285 city blocks.

During the 1936 season, Japanese beetle trapping work was carried on more extensively than during the preceding two years. The 10,000 new-type traps (which had been reconditioned and repainted) were again placed in operation in St. Louis. In addition to these, about 4000 of the old-type traps were widely distributed in the adjacent areas in St. Louis county. Small daily trap collections gave an early indication that the beetle population had been greatly reduced. Because of this indication of the success of the program, material and equipment were gotten in readiness so that newly infested blocks might be treated as quickly as trap collections showed the presence of infestation, in the hope that this might be responsible for still better results in 1937.

After the 1936 trapping season was over it was found that a total of 88 beetles had been captured in the city of St. Louis. Of these 88 beetles only 14 had come from the area treated in 1934, which was a reduction of 99 per cent for this area. Fifty-nine had been taken in the 1935 treated area, and only 15 had come from newly infested blocks, most of which were adjacent to the already treated territory.

These newly infested blocks, together with adjacent blocks in which egg deposition might have taken place, were treated as quickly as they were shown to be infested. This 1936 treated area contains 31.6 exposed soil acres, and has a total city area of 166 acres, or about 20 blocks, on which 15.8 tons of arsenate of lead were applied. Three contiguous blocks near the center of the 1934 treated area, from which 10 of the 14 beetles had been taken, were re-treated at the rate of 500 pounds of poison per acre.

Since a number of new houses and buildings had been built after the 1934 and 1935 treating work had been done, a survey was made to locate all soil that had been disturbed in such ways as to interfere with the effectiveness of the arsenate of lead treatment. Thirteen and a half tons of arsenate of lead was used in this re-treating work.

Since vegetable and flower gardens are regularly cultivated and plowed or spaded each year, so as to destroy or impair the effectiveness of lead arsenate treatment, they had not been treated. Although these gardens do not offer such favorable hibernating quarters as does the turf of lawns, there was at least some possibility that a few grubs might overwinter in them. In an effort to eliminate this possibility, all such gardens were treated with double-strength carbon disulfide emulsion.

The Japanese beetle work has been carried on as a cooperative project organized by the Missouri State Department of Agriculture, with the U. S. Department of Agriculture, Bureau of Entomology and Plant Quarantine, the city of St. Louis and Work Relief Agencies cooperating. Nearly all of the labor has been supplied by either the Federal Emer-

gency Relief Administration or the Works Progress Administration. Each year a conveniently located office has been established, and detailed records of all activities kept. A trained draftsman has been regularly employed to record the various activities on maps. During the 1936 season, treated blocks in which beetles were captured were mapped to show the locations of traps during all three seasons. Such areas were then studied in an effort to learn whether a condition existed that might be favorable to the beetle. Every effort was made during the 1936 season further to reduce trap collections in 1937.

The 4000 traps operated in St. Louis county did not reveal the presence of any additional infestation in the vicinity of St. Louis. The Bureau of Entomology and Plant Quarantine operated traps during a 30-day period in the height of the beetle season in Jefferson City, Columbia, Sedalia and Kansas City with negative results, indicating the probability of no other infestation in Missouri.

Since the fall of 1934 a state Japanese beetle quarantine has been in effect for the purpose of preventing the artificial dissemination of the Japanese beetle from the St. Louis infested area through the movement of certain products and materials which might be infested with the grub. The regulated area has been annually extended to include all newly infested blocks. This area is regularly scouted by a state quarantine officer, whose duty it is to warn all those likely to move regulated products and to enforce the quarantine. The Building Commissioner of St. Louis is cooperating by issuing a copy of the quarantine with each building permit issued for a building to be constructed in the regulated area. There has been only one case of refusal to cooperate with the quarantine officer. This case was prosecuted, and the verdict rendered in favor of the state.

The result of the work in St. Louis during the past three years is summarized in table 1.

It is important to note that of the 14 beetles captured in the 1934 treated area 10 were from three contiguous blocks near the center of the area. These blocks have been retreated with arsenate of lead at the rate of 500 pounds per acre. It is now believed that there are a number of conditions that are operating toward further reduction of the beetle population. It is likely that some of the isolated single beetle finds, in both the 1934 and 1935 areas, may represent females that had never been fertilized. As the population is cut down, the possibility of spread into hitherto uninfested and untreated territory is proportionally diminished. The treating work performed in 1935 should reach its maximum killing power on the grubs due to emerge in 1937. If future activities may be anticipated to be as effective as those of the past three years there is reason to presume that it may be possible to hold the St. Louis infestation to a limited area for an indefinite period and that eradication may not be impossible.—5-19-37.

EFFECTIVE May 10, regulations of the federal quarantine relating to the Japanese beetle were amended to add certain Maryland and Virginia districts to the area from which the movement, by refrigerator car or motor truck, of fruits and vegetables of any kind is restricted and to authorize the Chief of the Bureau of Entomology and Plant Quarantine to extend or reduce such area by administrative instructions.

White Grub Devastations in Iowa Nurseries

FLOYD ANDRE, *Iowa Experiment Station*,[1] *Ames*

White grubs constitute one of the major insect problems in Iowa, and each year numerous pastures and various cultivated crops are damaged by these pests. Occasionally some damage to nursery stock has occurred. During the season of 1936 there has been an unusually heavy infestation in nurseries. Population studies were made to discover the number of grubs present in various parts of these nurseries and to correlate the number of grubs present with the damage incurred.

Up to the present 34 species of *Phyllophaga* have been found in Iowa. A greater number of species normally occur in the more hilly, broken and timbered portions of the state than in the open sections. More species of adults apparently occur during a Brood A flight year than at any other time. From the standpoint of Iowa nurseries, however, all three broods are important and each has been found to infest nursery stock.

Species responsible for damage.—In the nursery where much of the data were secured for this paper the nursery man in charge estimated that white grubs had destroyed 6 million of a total of 13 million seedlings and cuttings which had been started in the spring. During the summer of 1936 more than 800 larvae were secured from various plantings in the nursery for rearing purposes. These larvae were confined individually in shell vials and reared to the adult stage so that identifications could be readily made. Of the original number 465 reached the adult stage, and all proved to be adults of *Phyllophaga implicita* (Horn). This particular species during many seasons is one of the most common and widespread of any of the 34 species known to occur in

Fig. 1.—Poplar cutting, showing gnawing injury by white grubs.

[1] Journal paper J409 of the Iowa Agricultural Experiment Station, Ames; project 128.

Iowa. The adults are general feeders and do not confine their feeding activities to any one host. On willow, poplar and elm this species may be found in abundance during the flight season of either Brood A, B or C years. Since these particular trees which serve as their host plants predominate throughout the state, *implicita* may be collected in any county in the state.

The grubs causing most of the damage to the state nursery in the spring and summer of 1936 belonged to Brood C, which, in the vicinity of Ames, is the smallest of the three broods. It was interesting, however, to find in some of the diggings representatives of all three broods; that is, Brood A was represented by second-year larvae, Brood B by eggs and recently hatched larvae, and Brood C, which was responsible for most

Table 1.—Population of white grubs in nursery.

Kind of Planting	No. 1/10,000-acre Counts	Total No. Grubs	Av. No. Grubs per Count	No. Grubs per Acre	Percentage of Plants Killed by Grubs
Poplar cuttings	100	1690	16.9	169,000	94
Locust seedlings	15	120	8.	80,000	21
Ash seedlings	15	69	4.6	46,000	15
Redbud seedlings	15	51	3.4	34,000	14
Wild grapes	15	34	2.3	23,000	2

of the damage, by third-year larvae until about July 15 and from then on until October 12 by larvae, prepupae, pupae and adults. The damage caused by Broods A and B, however, was not large in 1936; for that reason only larvae belonging to Brood C are included in the counts reported in the present paper. In the past it has not been unusual to find two broods represented in any given digging, but all three have been found on but a few occasions by the writer.

Determining white grub populations.—In an effort to estimate the population of white grubs, the writer selected for a unit of measurement one ten-thousandth acre, which is slightly larger than four square feet. A hollow square of 1 by 3-inch wood, the inner edge of which measured the exact area, was placed over the unit to be sampled; and the soil was carefully lifted. The grubs were removed from the cakes of earth, and all the holes were dug to a depth of at least 24 inches to make sure that all the individuals were collected. Most of the grubs, however, were found in the upper 4 or 5 inches. Samples were taken in various plantings in the nursery. More grubs occurred in some plats of trees than in others, table 1.

Injury to cuttings.—As is shown in fig. 1, the larvae injured the cuttings by chewing through the outer bark, the cambium and into the woody internal portions. In some instances the cuttings were eaten into; in others the cambium layer was girdled; and in others the gnawing was evident in but a few scattered spots. More than 90 per cent of the cuttings were dead or dying by early September, fig. 2.

Injury to seedlings.—Seedlings were injured by the grubs cutting off the tap root a distance varying from 2 to 5 inches below the soil surface. This resulted in the gradual wilting and drying up of the plant within a short period.

Damage to other nursery plantings in past.—Between 1918 and 1931 the state entomologist of Iowa received 233 letters concerned specifically with white grubs and their damage to various economic crops. Of these letters 50 related to strawberry damage, two to raspberry damage, and one to an infestation in nut trees, whereas all the others were ques-

Fig. 2.—*Top*, Poplar trees which grew from cuttings made in the spring of 1935. In this case only a few lived out of several hundred thousand which were planted. *Bottom*, Poplar cuttings during June 1936, at which time about 70 per cent of them had been killed by grubs. By fall more than 90 per cent of the cuttings were dead.

tions with respect to field, horticultural and floricultural crop problems. Our records in Iowa show that white grubs first appeared in unusual numbers in the northeast corner of the state in 1909 and since then they have been spreading south and westward. The largest nurseries in the state are in the most southwestern Iowa county, and this year (1936) two of the nurseries in this county experienced the most serious damage by grubs that they have so far had.

Henry Ness, assistant state entomologist, each year since 1907, when he started working on nursery inspection, has found that strawberry beds are badly damaged in various portions of the state. In numerous instances the beds have been almost a total loss.

In one particular instance in 1936 a grower near Spirit Lake lost about 80 per cent of his strawberry bed; and he estimates that the loss incurred in his nursery alone would pass $500.

Some problems confronting Iowa nurserymen.—One Iowa nurseryman recently purchased 120 acres of land and planted it to various nursery stock. It was so badly damaged by white grubs that he decided to sell it and move his nursery to some other location. He asked the state entomologist to recommend the best place to buy a piece of land which would be relatively free from damage by white grubs. The following suggestions were offered: (1) Select land as far away as possible from large forested areas, woodlots and permanent grass pasture land. (2) Keep to a minimum the number of larger trees serving as food plants for the adult beetles, by disposing of large trees.

Strawberry growers have recently been more concerned than ever before in the matter of selecting suitable areas on their farms for raising the plants for selling purposes. One grower has procured the necessary equipment for spraying the foliage of trees which serves as food for the imago *Phyllophaga*. By the use of this spray and by following the proper cultural practices he hopes to keep to a minimum the white grub population in his strawberry beds which will be located about one-half mile from the trees.—1-23-37.

The Grasshopper Situation in Iowa

C. J. Drake and G. C. Decker, *Iowa State College*,[1] *Ames*

Grasshoppers, in common with all other forms of animal and plant life, are an integrant part and product of their environment. From the very beginning, man's conquest of the prairies has been contested from time to time by serious outbreaks of grasshoppers and such outbreaks may be expected to recur again and again whenever environmental conditions over wide areas are favorable for the mass production of grasshoppers. As in the case of individuals, epidemic outbreaks are born, grow, mature and decline or suddenly die.

The current outbreak had its beginning in 1931 and the situation has remained threatening since that time with more or less damage occurring each year. In the fall of 1934 the survey showed that four counties were heavily infested, 10 moderately infested and 12 lightly infested. It was estimated that between 1200 and 1500 tons of bait might be needed the following year. The spring of 1935, however, was wet and backward and the eggs did not hatch until very late, approximately 75 per cent of the nymphs hatching after June 1. Many of the young hoppers were destroyed by heavy rains and a few died of diseases. The luxuriant vegetation provided a great abundance of wild and cultivated food plants for

[1] Journal paper J405 of the Iowa Agricultural Experiment Station, Ames; project 372.

the remaining hoppers, and damage was not very noticeable until late in the season. Consequently, less than 500 tons, or only about one-third of the estimated quantity of bait, were used. In Shelby and adjoining counties where a light drought prevailed in the spring, *Melanoplus mexicanus* (Sauss.) began hatching early and field observations seemed to indicate that there was a fairly large second generation. During the third week of September it was not uncommon to find as high as 100 first, second and third-instar nymphs per square yard in alfalfa, stubble and pasture fields. Most of these nymphs matured and many adults of the second generation were observed ovipositing in late October and early November.

The limited poisoning operations, the successful development of a partial second generation of *M. mexicanus* and the occurrence of extensive flights into Iowa from the west in late August and September apparently all combined to produce an unusually heavy oviposition. The adult and egg surveys in the fall of 1935 indicated a dangerous situation existed in 29 counties and a possible need of 2444 tons of bait for 1936. Comparatively warm dry weather in the spring of 1936 produced an early hatch and was very favorable for the young hoppers. Nymphs of *Melanoplus mexicanus* and *M. bivittatus* (Say) began hatching in April and *mexicanus* adults began to appear late in May but no *bivittatus* adults were observed until the first week of June. The nymphs of *M. femur-rubrum* (DeGeer) and *M. differentialis* (Thomas), however, did not appear in great numbers until about the first of June. In 1936, as in 1935, some of the eggs of *M. mexicanus* which were deposited early in the season began hatching in August and September. Young nymphs of the second generation first appeared in the field about the middle of August and by mid-September second and third-instar nymphs were fairly common in most of the western counties. The nymphs, however, were less abundant than in the fall of 1935, but a much larger area was involved. Also, the percentage of second generation nymphs which reached maturity was much smaller. Some second generation females were observed laying eggs in late October and many females contained well developed eggs.

In order to determine definitely whether the nymphs appearing in the fall represented a second generation or a delayed hatch of overwintering eggs, *M. mexicanus* adults were collected on June 10 and placed in a cage over soil known to be free of grasshopper eggs. Oviposition in this cage was first noted on June 25, and young nymphs first appeared on August 28. This was about 10 days after nymphs of the second generation had been observed in the field. Many of the nymphs escaped from the screen cage and only 12 of the 27 which remained reached maturity. On October 20 the soil under the cage was carefully sifted and 19 egg pods were found, of which 12 were unhatched, three hatched and four destroyed by carabid larvae.

In 1934 *Ageneotettix deorum* (Scudder), *Orphylella speciosa* (Scud.) and other prairie species increased greatly in numbers and they did considerable damage to pastures in 1935. In 1936 they practically destroyed thousands of acres of bluegrass pasture in western Iowa. When the pastures begain to fail the larger crop-infesting species migrated to nearby

small grain and corn fields but the *Ageneotettix* and allied species remained to complete the job of destruction. In many cases all green vegetation was eaten to the ground by the first of July and all new shoots were clipped off as fast as they appeared. At midday it was not uncommon to find dry grass stems, dead weeds and fence posts in and around pasture fields completely covered with grasshoppers, and populations ranging from 30 to more than 100 per square yard were frequently encountered. Many persons who failed to investigate field conditions assumed that the pastures had been burned out by drought. Investigation, however, revealed that the apparent drought damage to bluegrass pastures early in the season could be very clearly correlated with the grasshopper population, especially range-feeding species, and that lightly infested pastures subjected to the same weather conditions remained green three to four weeks after heavily infested fields were brown and barren. Furthermore, the grasshopper-damaged pastures showed much less recovery following the fall rains. In some cases the range species either migrated or nearly ate themselves out of existence, as the egg survey indicates a decline in the number of eggs in the most heavily infested areas.

Dissosteira carolina (Linn.), *Hippiscus* spp., *Chortophaga viridifasciata* (DeGeer), *Schistocerca americana* (Drury), *S. lineata* (Scudd.) and numerous other species also showed a considerable increase in numbers in 1936.

The 1936 control campaign was incomplete and only partially effective. Only a small quantity of bait was available when it was most needed in the spring and by the time the much needed supplies became available many of the hoppers had attained the adult stage and the population was constantly shifting from place to place. Under these conditions the grasshoppers were difficult to control and treated fields often became reinfested soon after they had been poisoned. Furthermore, soon after bait materials began to move into Iowa in large quantities the drought became severe and many farmers were so discouraged that they gave up poisoning.

In the summer of 1936 Iowa experienced the most intense and prolonged heat wave ever recorded in the state. It was difficult to poison grasshoppers during most of this long period of high temperatures and hot dry winds because many of the grasshoppers never left their roosts in the trees, on fence posts, weeds and similar objects to come down and feed on the ground between sunrise and sunset. Throughout the southern and western parts of the state where the population was large many apple orchards, windbreaks and other trees and shrubs were defoliated and some of the twigs were badly barked. In many counties the grasshoppers practically destroyed most of the sources of winter food and cover needed by quail, pheasants and many other forms of wildlife.

In Shelby, Audubon, Pottawattamie and other heavily infested counties, where bait was available at hatching time and where additional bait was received before large-scale migrations began, the campaign was highly successful. The grasshopper population in this area was greatly reduced and thousands of acres of corn and other crops were saved from the hoppers, but subsequently these crops were seriously damaged by

drought. In these counties the fall survey showed no increase in the population and in some cases a decline in the potential for next year. On the other hand a considerable increase occurred in the infested counties where only a very limited amount of poisoning was done. About 4463 tons of bait, approximately twice the estimated amount, were used in 1936, and, if large quantities of bait had been available at the proper time, two or three times this amount could have been used to advantage. Approximately four-fifths (3527 tons) of the total bait used in 1936 was broadcast in the 29 counties included in the 1935 grasshopper survey. Of this amount 2201 tons were applied in Pottawattamie, Shelby, Crawford, Audubon, Woodbury, Monona, Harrison, Ida and Cass counties.

The adult and egg surveys made in the fall of 1936 showed grasshoppers to be more than normally abundant in 83 of the 99 counties of Iowa. Of these, 14 counties were very heavily infested, 44 heavily infested and 25 moderately infested. In the remaining 16 counties the population was only slightly above normal. The survey not only showed the infestation to be widespread but also showed that there were then more grasshopper eggs in the soil than at any other time during the last 40 years. It has been estimated that about 16,000 tons of bait may be needed in Iowa in 1937 unless weather conditions are very unfavorable for the hoppers during and shortly after the hatching period next spring.—1-23-37.

The Vetch Bruchid, *Bruchus brachialis* Fahraeus

J. S. PINCKNEY,[1] *U. S. Department of Agriculture, Bureau of Entomology and Plant Quarantine*

With the introduction and establishment of the vetch bruchid, *Bruchus brachialis* Fahraeus, into the United States along the middle Atlantic seaboard, the attention of quarantine officers and of producers of western vetch seed has been focussed upon a new European pest. This bruchid was first discovered in this country on June 24, 1930, at Haddon Heights, N. J., by L. J. Bottimer.[2] Bridwell & Bottimer (1933) made some preliminary investigations of the insect which were published in 1933. In response to the interest and concern of quarantine officers and vetch seed producers throughout the country, the Bureau of Entomology and Plant Quarantine started investigations in 1934, and the writer was assigned to ascertain the extent of establishment in the east and to begin a study of the biology of this bruchid in North Carolina. The results indicated that the bruchid was well established along the eastern seaboard and that in the short period since its introduction it had seriously crippled the vetch seed industry of North Carolina.

Nature of injury.—In practically all cases of heavy infestation most

[1] The writer is indebted to Dr. P. N. Annand, who made these investigations possible, and also to C. C. Hill, under whose direction this work was carried on, for their constant interest and many helpful suggestions in the preparation of this paper. He also wishes to thank E. J. Udine for the photographs used.

[2] This information relative to the first recovery in this country of *B. brachialis* was transmitted to me by Mr. Bottimer in a letter of January 5, 1937, and antedates information previously released in earlier publications.

of the seeds in every pod are attacked. The larva feeds in the seed and consumes a sufficient quantity of it to destroy its viability. Even when the larva dies before complete development is attained, the seed is usually fatally damaged. When full growth is achieved, as is generally the case, the seed content is destroyed to the extent shown in fig. 1, *A*. In this case all of the individuals had reached the adult stage, two of them had emerged, and in one seed the head of the unemerged adult may be seen in the opening.

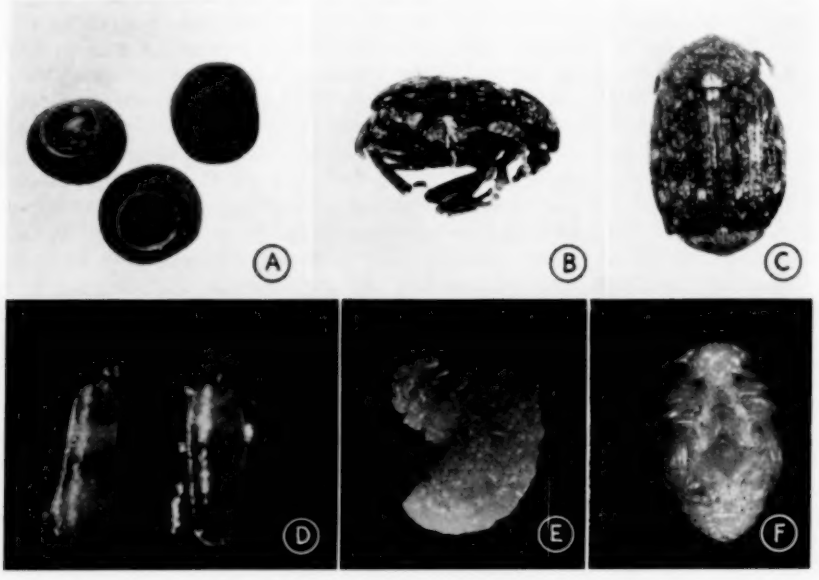

Fig. 1.—Stages in the life history of the vetch bruchid, *Bruchus brachialis* Fahr. *A*, Typical injury to vetch seed by larvae. *B*, lateral view of adult, greatly enlarged. *C*, Dorsal view of adult, greatly enlarged. *D*, Eggs, greatly enlarged, showing the rings. *E*, Fourth-instar larva, greatly enlarged. *F*, Pupa, greatly enlarged.

Economic importance.—*Bruchus brachialis* affects only the production of seed of the vetches attacked by it. No injury to the plant, other than to the seed, has been noted at any time. Consequently, when the plant is grown as a forage cover or green manure crop, there is no resultant loss from the prevalence of the beetle in the field. When the production of seed is the principal objective in growing vetch, however, the bruchid's presence immediately becomes of major significance. Bottimer reported an infestation of about 81 per cent at Haddon Heights, N. J., shortly after the discovery of this insect in the country. In central North Carolina all of the vetch fields visited during the last three years were found to be heavily infested, both smooth and hairy varieties of *Vicia villosa* being attacked alike. In all fields examined at least 50 per cent of the seed was found infested; several fields had over 76 per cent, and a maximum infestation of 90 per cent occurred in one field. This high degree of infestation in North Carolina has so seriously handicapped the

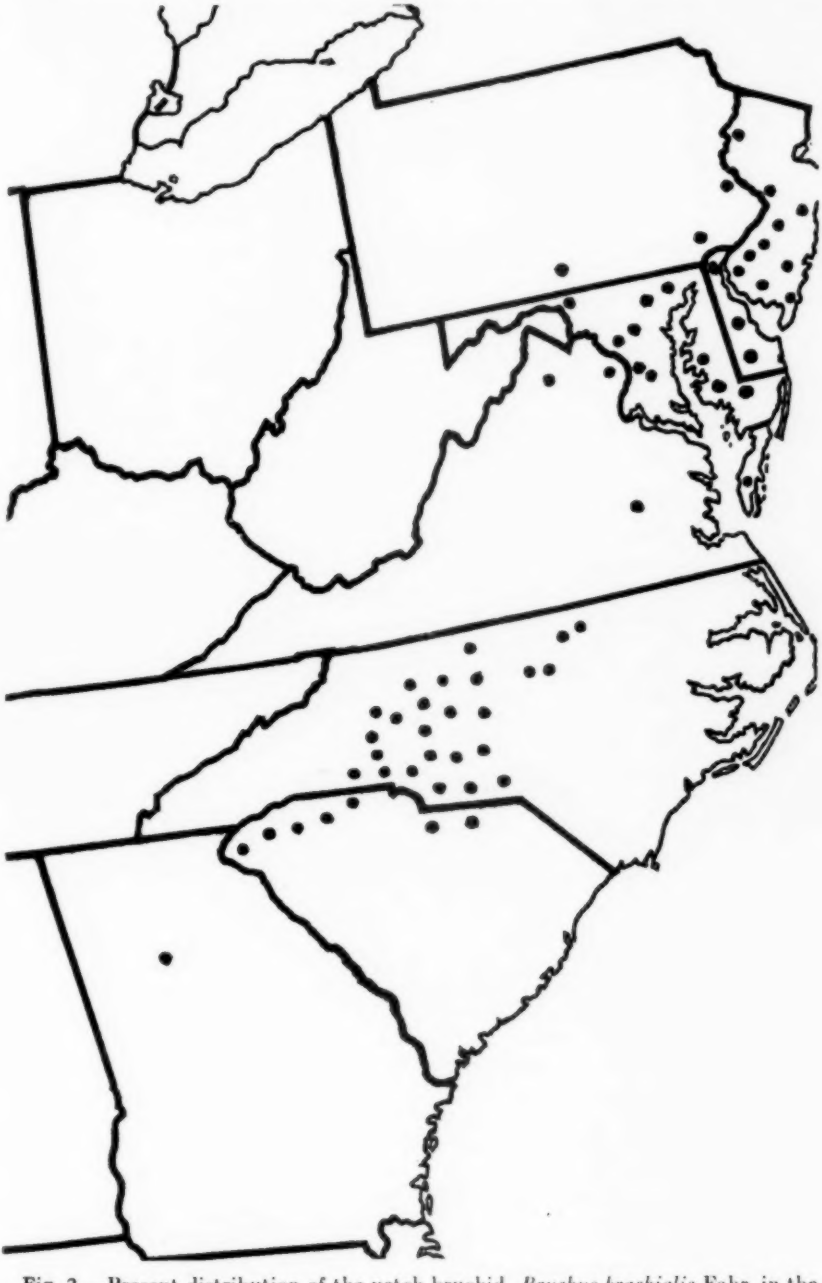

Fig. 2.—Present distribution of the vetch bruchid, *Bruchus brachialis* Fahr. in the United States.

production of sound vetch seed that most farmers have discontinued growing vetch for this purpose, with a consequent heavy monetary loss. It can thus readily be seen that the presence of the bruchid in the middle Atlantic states is cause for grave concern to agriculturalists in other areas of the country that produce vetch seed.

Distribution in the United States.—No extensive, detailed survey has been made to determine the actual limits of distribution; nevertheless, for the last three years the vetch-producing areas in the middle Atlantic states have been thoroughly examined by the staff of the Carlisle, Pa., laboratory of the Division of Cereal and Forage Insect Investigations, in connection with surveys conducted for other insects. These observations have been supplemented by those of B. J. Landis, of the Division of Truck Crop and Garden Insect Investigations, during a survey of peas in the eastern states in 1935, and by further work by L. J. Bottimer.[3] The present known distribution in the United States is shown in fig. 2 and includes besides the District of Columbia, the following states and counties:

New Jersey.—Atlantic, Burlington, Camden, Cape May, Cumberland, Gloucester, Mercer, Ocean, Salem and Warren counties.

Pennsylvania.—Bucks, Chester and Franklin counties.

Delaware.—Kent, New Castle and Sussex counties.

Maryland.—Baltimore, Dorchester, Harford, Howard, Montgomery, Prince Georges, Talbot, Washington and Wicomico counties.

Virginia.—Fairfax, Henrico, Northampton and Warren counties.

North Carolina.—Alexander, Anson, Cabarrus, Catawba, Cleveland, Davidson, Davie, Durham, Forsyth, Gaston, Granville, Guilford, Iredell, Lincoln, Mecklenburg, Montgomery, Orange, Randolph, Richmond, Rockingham, Rowan, Stanly, Union, Vance and Yadkin counties.

South Carolina.—Cherokee, Chesterfield, Greenville, Lancaster, Oconee, Pickens and Spartanburg counties.

Georgia.—De Kalb county.

Host plants.—All observations indicate that the feeding of *Bruchus brachialis* is apparently limited to plants of the genus *Vicia*. It attacks both the smooth and the hairy varieties of the species *V. villosa*, which is the one most commonly found in cultivation in the middle Atlantic states. In addition to smooth and hairy vetch, Bridwell & Bottimer (1933) report finding it lightly infesting bird vetch, *V. cracca*, and also woolly-pod vetch, *V. dasycarpa*, in experimental plantings.

In the spring of 1936, rod-row plantings of a number of species of vetch were made at the Piedmont Experiment Station, at Statesville, N. C., in cooperation with R. E. Stitt, of the Bureau of Plant Industry, U. S. Department of Agriculture, to observe their susceptibility to attack by the bruchid and their comparative infestations. Although egg deposition was heavy on *Vicia villosa* and *V. dasycarpa*, the bruchid did not oviposit at all upon Louisiana vetch, *V. ludoviciana*, narrow-leaf vetch, *V. angustifolia*, bitter vetch, *V. ervila*, or Monantha vetch, *V. monantha*. Only one egg was found on two rows of common vetch, *V. sativa*, and

[3] The records contributed by Mr. Bottimer included all those from New Jersey, Delaware, Georgia and the District of Columbia, most of those from Maryland, and some from Virginia, North Carolina and South Carolina. Other records from Virginia were contributed by Mr. Landis.

three eggs on one row of Hungarian vetch, *V. pannonica*. No adults emerged from either of these last two species. It is interesting to note that in woolly-pod vetch the bruchid attacked the seed readily but less than 50 per cent of the seed attacked produced adult bruchids, whereas in the *villosa* varieties the average percentage of adults produced from attacked seed varied between 80 and 90. Although it is too early in these investigations to state that any of these varieties are immune, a wide variation in susceptibility to attack by the bruchid is certainly indicated.

Adult. DESCRIPTION AND SEX DIFFERENCES.—The adult, fig. 1, *B* and *C*, when first formed, closely resembles the last stage of the pupa, for the coloration is about the same, and the body is soft with the abdomen much extended. Within about two days, however, the normal black coloration is assumed and the body hardens, while the abdomen contracts to its final size. When this condition is reached the adult breaks open the lid it has made in the seed and emerges within the pod, where it awaits dehiscense for liberation, as it is unable to cut its way out of the dried pod.

The beetle is small, 3 to 3.5 mm. in length, ovate, black, with the pronotum and the elytra conspicuously but irregularly spotted with whitish patches of hair. The sides of the breast and the venter are whitish maculate, and the pygidium is covered with a whitish pubescence. The elytra are short. The front legs are rufotestaceous, and the hind femora strongly dentate, with the hind tibiae ending in two spines at the apex beneath. The sexes are easily distinguished by salient characters. The front legs and the antennae of the male are reddish brown, while in the female the femur of the front leg is usually black, except at the apex, where it is reddish brown, and the antennae are black, except for the first four or five joints and the last, which are also reddish brown. The most distinctive and reliable character for differentiating between the sexes, however, is the presence of a distinct truncate projection at the apex of the middle tibiae of the male, which is lacking entirely in the female.

LONGEVITY.—The adult vetch bruchid lives for 10 to 12 months under natural conditions. The adults of the new generation emerge from the seed during the last of June, in July and in the first part of August, and remain quiescent within the pods until the latter dehisce or are broken open by some mechanical means. When this takes place the released beetles immediately fly away, presumably to their hibernation quarters. After passing the winter in hibernation the beetles begin to appear in the vetch fields about April 15, a week or 10 days before the plants begin to bloom. They are active throughout the day, flying about the vines and climbing over them in search of pods upon which to oviposit. They are easily aroused and when disturbed either fly away quickly or feign death and drop to the ground with their legs tightly folded, quickly becoming active again if unmolested. By the third week in June all adults of the overwintering brood have disappeared from the fields.

MATING.—A study of the habits of the beetles during their periods of greatest activity indicates that mating takes place during the period of oviposition in the spring. Careful observations show that the beetles refuse to copulate at other times of the year. At the time of emergence they usually fly away from the fields upon release from the pods. How-

ever, when emerging from seed in storage or at the seed-cleaning mills, where they are congregated in thousands, the sexes pay no attention to each other, and even when placed in vials where escape from contact with one another is impossible no case of copulation has ever been observed at any other time than that normal to the species, in the spring of the year.

Sex Ratio.—Examination of 1000 individuals of the new generation at the time of their emergence from the seed resulted in the following division of the sexes: 40.4 per cent were males and 59.6 per cent females.

Oviposition.—Observations on the oviposition habits of the beetle show that the female ascends the stalks or flies directly to them. Upon reaching a pod, the female moves about from one side to the other until she decides upon a suitable location for depositing the egg. Usually she selects a point near and parallel to its margin, although when pods are scarce and beetles plentiful the eggs are deposited indiscriminately over the surface of the valves. Invariably the female faces toward the stalk when ovipositing. The egg is placed with its posterior end directed toward the apex of the pod. In the act of oviposition the beetle curves the end of the abdomen downward and by rhythmic motion of the body quickly deposits the egg upon the surface of the valve of the pod without attempting to insert it. The egg is fastened to the surface by a viscid fluid, which, upon drying, is about the color of the egg. After deposition the female moves to another spot, or flies to another pod, and in this manner places the eggs, one at a time, upon the pods of the host plant. As many as 42 eggs have been found on one pod, though the usual number is about 10. Ovipositions were timed in the field and the average length of time required for the deposition of an egg was 59 seconds, with a minimum of 45 seconds and a maximum of 68.

Egg. Description.—The egg, fig. 1, *D*, is oblong although it converges somewhat at the posterior end, with rounded ends and nearly straight sides. The freshly deposited egg is about .6 mm. long, .2 mm. wide at the widest point, and .2 mm. high. The surface is finely wrinkled. At first the egg is pale yellow but by the third day after deposition, as the embryo develops, two distinct dark rings appear within, one at or near the posterior end and the other just about in the center. The position and appearance of these rings are shown in fig. 1, *D*. As development of the egg continues, the head of the larva becomes visible, and the two rings lose their color to a certain extent and merge in the lower part of the egg. The shell of the hatched egg is usually white, and is generally filled with frass, produced by the larva in boring through the chorion of the egg and the valve of the pod.

Incubation Period.—The duration of the incubation period was determined in the field by securely covering with cheesecloth, pods bearing freshly deposited eggs and then making daily examinations of the protected eggs until they hatched. A record of 70 such eggs was kept with the following results: eggs observed, 70; eggs hatching, 53; eggs failing to hatch, 17; proportion of eggs hatching, 75.7 per cent. The average length of the incubation period for these eggs was eight days, with a minimum of five days and a maximum of 11 days. The incubation period in the field was checked by observations in the laboratory. This was done

by bringing in freshly deposited eggs, removing them from the pods, and placing them in petri dishes at room temperature for daily observation. A record of 80 eggs was made in the laboratory, with results very closely approximating those in the field. Eggs observed, 80; eggs hatched, 56; eggs failing to hatch, 24; proportion of eggs hatching, 70 per cent. The average length of the incubation period in the laboratory was eight days, as was that in the field, and the minimum period was six days, one more day than the minimum period out of doors, although the maximum was 11 days, as it was in the field.

Larva.—The first-instar larva, one day after hatching, is .42 mm. long and .16 mm. wide, and the head capsule is .12 mm. wide at its greatest width. The body at this time is not so stout in proportion to its length and is less curved, as compared with its appearance after the first molt. This first-instar larva differs widely in important characters from the subsequent three instars, by the presence of three pairs of short, temporary legs and an H-shaped chitinous plate on the first thoracic segment. These features are not present in later instars. After entering a seed and feeding for a few days the larva casts its skin and it then assumes the appearance of the full-grown larva, except in size. The fourth-instar larva, fig. 1, *E*, is yellow, fleshy, thick and curved. The head is elongate oval, somewhat attenuate posteriorly, and is deeply retracted into the thorax. The thorax itself is somewhat larger than the rest of the body.

The young larva hatches and enters the pod in one operation, by gnawing through the chorion of the egg at the broader end and then on through the valve of the pod. Some larvae die within the pod before finding a seed, while others die before effecting entrance after finding a seed. The majority of the larvae, however, find and enter the seed without difficulty. Careful examination shows that the larvae may enter the seed at any point; 90 per cent, however, entered through the hilum or in close proximity to it. The entrance hole may easily be seen under low-power magnification as a small, dark spot, or circular hole, and it is usually filled with frass. As many as six entrance holes have been found in one seed, but no instance of the development of more than one pupa has been noted in the dissection of large quantities of infested seed. Generally the stronger and more aggressive larva destroys the weaker when they meet within the seed. The larva feeds within the developing seed, and as its growth continues it passes through four instars and a prepupal stage before pupating. When full grown the larva prepares the pupal cell by packing and cementing the dry frass, with which its body has been surrounded during growth, against the walls of the cavity. It then thins the outer skin of the seed along the edge of the circular area at one end of the cell, forming the cap or lid which is pushed away when the adult emerges. This thinning of the seed coat causes a thin ring to appear, which is visible under low-power magnification on a normally ripened seed. Where the seed has been harvested before becoming fully ripened, it retains a greener color, and the cap or ring may be seen very distinctly as a narrow ring of pale green against the darker green of the seed. Shortly after preparing its pupal cell the larva becomes quiescent and enters the prepupal stage. This stage is readily indicated by the constriction at the thorax, the less curved body, and the gradual assumption

of the pupal characters. The larval stage is approximately two weeks in duration though it may vary a few days either way with variable weather conditions.

Pupa.—When first formed, the pupa, fig. 1, *F*, is shining and yellowish white, 3.4 mm. long and 2.3 mm. wide. There is no change in its color for the first three days, except for the eye. Very faint, minute spots of red appear within the facets in the eyes and by the third day they are quite distinct. They gradually enlarge and become a deeper red until the

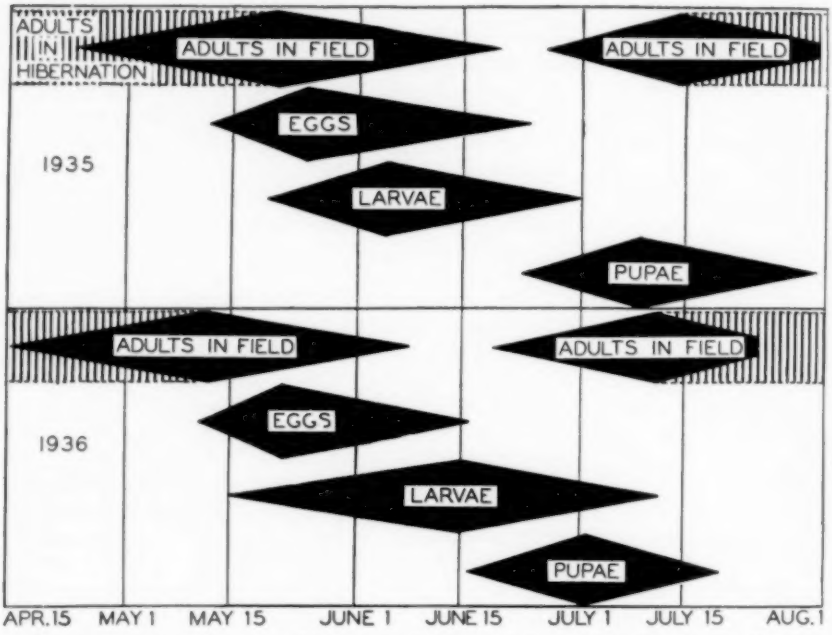

Fig. 3.—Chart of the seasonal history of the vetch bruchid in North Carolina for 1935 and 1936.

eye has become a uniform shade of dark reddish brown, bordering on black. By the fourth day after pupation the eyes are uniform in color; faint lines of brown appear along the inside of the hind coxal cavity, and the mandibles become brown at the apex. On the fifth and last day of the pupal period the body turns pale reddish, with the darkest color at the articulations of the legs, while minute black hairs appear on the elytra and the thorax. The average length of the pupal period is five days, with a minimum of four days and a maximum of six.

Seasonal history.—In North Carolina the overwintering adults begin emerging from hibernation during the middle of April, and by May 1 large numbers of the beetle are present in the vetch fields. As soon as the pods develop, oviposition commences. The peak of oviposition is reached during the last week in May, but egg deposition continues until the third week in June, when all of the adults of the hibernating brood have dis-

appeared. Larvae are present in the developing seed from the middle of May until harvest time in the latter part of June. When the vetch is cut, the larvae are in all stages in the seeds, from the first to the fourth instars, but the majority of them have reached the third or fourth instar. During the harvest period and previous to it, or during the time the seed is being cleaned, the weevils pupate and emerge. Pupation commences about June 15, and pupae have been found in the field as late as the first week in August. Adults from the earliest deposited eggs emerge during the last week in June, and emergence of beetles of the new brood usually reaches its peak about July 15, at which time they begin migrating to hibernating quarters. It is not known where hibernation occurs, although intensive efforts have been made to discover hibernating beetles. The seasonal histories for 1935 and 1936 are shown in fig. 3.

Parasites.—Since its introduction into this country, a total of seven species of native American Chalcidoidea have been reported as parasitizing this bruchid. Bridwell & Bottimer (1933) reared the following species: *Eupelmus cyaniceps amicus* Gir., *Eupelmella vesicularis* (Retzius), *Microdontomerus anthonomi* (Crawford), *Zatropis incertus* (Ashm.), *Habrocytus* sp. and *Eurytoma tylodermatis* Ashm. Of this group, the writer has reared *Eupelmus cyaniceps amicus*, *Microdontomerus anthonomi* and *Eurytoma tylodermatis*, and in addition has reared *Lariophagus distinguendus* (Foerst) and *Bruchobius mayri* (Masi). *Bruchobius mayri* is a European chalcid parasite of *B. brachialis* and was reared for the first time in this country during the growing season of 1936 from material collected in Rowan county, N. C. Many eggs have been collected during the last two years and kept under observation in the laboratory, but no egg parasite has been reared from them.

Control and prevention of spread.—Thus far no methods have been devised for controlling this pest in the field. It appears that the development of successful control measures will be dependent on a more complete knowledge of the habits and biology of the species. Information regarding the place of hibernation is of particular importance, both from the standpoint of securing possible field control and to furnish additional information with respect to commodities which might harbor the insect and serve as a means of transportation.

Investigations of the biology of this insect in North Carolina have suggested a number of precautionary measures that should be taken to guard against the distribution of the vetch bruchid outside of the present infested area. Because of the preliminary nature of the experimental data available these can be considered at present only as suggestions. They may be summarized as follows:

(1) Delay in threshing and cleaning to permit as nearly complete emergence of the adults as possible. Under conditions prevailing in North Carolina, if the threshing is delayed as long as practicable and the seed not cleaned until the end of August, most of the adults will have escaped and the hollowed-out seed will be winnowed out in the cleaning process. In the course of cleaning, most of the seeds from which beetles have escaped are removed, whereas those which still contain beetles, either dead or alive, go in with the good seed.

(2) Postponement of sacking the seed as long as possible in the fall.

Because of the long period in which the beetles are known to survive under hibernation conditions in the field, it is possible that beetles which emerge in closed sacks may remain alive for a long period, particularly those that crawl back into a hollowed out seed from which another beetle has emerged, which is a habit that is exhibited when the beetles are held in confinement. Preliminary indications are that a few living beetles may remain in the seed until April and for probably a longer period.

(3) Delay in the shipment of sacked seed until the summer of the year following production. It seems very likely from available data that no bruchids will remain alive in sacked seed after the summer following production, and if the seed is handled as previously suggested all of the adults very probably will have died by that time.

(4) Fumigation to kill emerged or unemerged beetles in sacks, in the case of early shipments. Work done in the summer of 1935–36, by A. C. Johnson, of the Division of Control Investigations, and the writer, indicates that with a load of 1500 pounds of seed per 100 cubic feet of chamber space, a dosage of 7 ounces of liquid hydrocyanic acid (HCN) per 100 cubic feet, applied in a partial vacuum of 28 inches sea level datum, held throughout a two-hour treatment at temperatures of 80 to 90° F, will kill all of the bruchids. Other tests also indicated that the bruchid could be killed by fumigation with liquid hydrocyanic acid under atmospheric pressure in a load of 15,000 pounds of seed per 1000 cubic feet of chamber space and with a dosage of 3 pounds per 1000 cubic feet volatilized and introduced into the fumigation chamber as a gas, with a 24-hour exposure at temperatures not lower than 75° F during fumigation. Tests of fumigation with 20 pounds of carbon disulfide (CS_2) per 1000 cubic feet for 24 hours at atmospheric pressure and temperatures of 80° F or over showed no survival. Tests were also made, through the cooperation of the seed testing laboratory of the Bureau of Plant Industry, to determine the effect of this treatment on the viability of the vetch seed. It was found that there was practically no decrease in the germination of vetch seed as a result of any of these treatments.

(5) Prevention of the movement of vetch hay to uninfested areas. Owing to the imprisonment of beetles in the closed, immature pods contained in vetch hay and the ability of the beetles to live for at least 12 months under these conditions, the movement of vetch hay out of infested areas must be considered definitely hazardous, at least until after the time when the adults normally die in the field. Present information indicates that vetch hay can not be moved safely until midsummer of the year following harvest.

Dangers involved in foreign importations.—The vetch bruchid is widely distributed in Europe, the literature indicating that it occurs generally in Austria, France, Spain and Italy, and also in Algeria and Asia Minor. Dead adults of *Bruchus brachialis* have been found by the Division of Foreign Plant Quarantines in seed from Hungary, Poland, Germany, Spain, Czechoslovakia and Palestine. Examination of limited amounts of seed from Latvia, Lithuania, Union of Soviet Socialist Republics, Sweden, Denmark, England and Canada revealed no infestations. Shipments of vetch seed from Japan have been repeatedly examined and no specimens of the bruchid have been found in them. In-

formation from the Seed Laboratory of the Bureau of Plant Industry shows that there has been an average annual importation of 2,454,167 pounds during the period from 1920 to 1935. Entries from these shipments have been made in every month of the year; the heaviest shipments, however, have usually been made in the spring and fall months.

The principal importations during this time have been from Austria, Canada, Czechoslovakia, Denmark, Germany, Great Britain, Hungary, Latvia, Lithuania, Holland, Poland, Sweden, Finland and Japan. It appears that the first shipments for consumption entry from Japan arrived in 1935, entering at the ports of San Francisco, Calif., and Portland, Ore. The Division of Foreign Plant Quarantines reports the finding of dead *Bruchus brachialis* in commercial shipments during the period May 1926 to September 1935 as in table 1.

Table 1.—Dead *Bruchus brachialis* found in commercial shipments of vetch seed, May 1926 to September 1935.

Host	Origin	No. Interceptions
Hairy vetch	Germany	1
Hairy vetch	Hungary	3
Bitter vetch	Palestine	1
Vetch	Hungary	1
Vetch	Spain	1

All interceptions made by the Bureau through September 1935 on commercial shipments are included in the above tabulation, and no living bruchids were found at any time during this period. On July 20, 1936, however, the entry of vetch seed was transferred from Regulation 2 to Regulation 3 of the Rules and Regulations supplemental to the Nursery Stock, Plant, and Seed Quarantine No. 37, on account of certain seed weevils, particularly *Bruchus brachialis*. This action resulted in placing the entry of vetch seed under permit and subject to inspection as a condition of entry. Since this change went into effect and up to and including December 2, 1936, some 49 commercial shipments totaling 2,036,061 pounds of vetch seed have entered various ports. Eleven of these shipments were found to be infested with living *Bruchus brachialis*, and as a result were fumigated as a condition of entry. Three types of treatment have been employed—fumigation with hydrocyanic acid under atmospheric pressure and under vacuum, and fumigation with carbon disulfide. These infested shipments arrived at the ports of New York, Baltimore, Norfolk, Charleston, Mobile and New Orleans.

It is evident from the interception of living bruchids in 11 of the 49 shipments in 1936, that there is serious danger involved in foreign importations and that fumigation of shipments will be a necessity.

Summary.—The vetch bruchid, *Bruchus brachialis*, has become established in the United States in New Jersey, Delaware, Pennsylvania, Maryland, the District of Columbia, Virginia, North Carolina, South Carolina and Georgia. Its importance as a pest of vetch seed has been demonstrated by the recent heavy losses resulting from its attacks. This insect has one generation a year and does not breed in dried seed. The eggs are laid on the green pods in the spring. The larvae feed within the seed and complete their development there. The adults emerge during summer. The hibernation habits of the species are unknown. There appears to be wide variation in the susceptibility to attack by the

bruchid of the various species of vetch, the smooth and hairy varieties of *Vicia villosa* being most generally and most severely infested.

The greatest danger of transportation out of the infested area lies in the shipment of vetch hay and in the movement of seed before all the beetles are dead in the seeds and sacks.

Interception of living beetles in commercial shipments from Europe in 1936 indicates that fumigation of the seed will be necessary for all shipments. Fumigation with hydrocyanic acid gas, both under vacuum and at atmospheric pressure, was found to be effective. The effectiveness of carbon disulfide as a fumigant for the adult vetch bruchid was indicated. Viability of vetch seed apparently was not reduced by fumigation with hydrocyanic acid gas.—6-14-37.

Literature Cited

Bridwell, J. C. and L. J. Bottimer. 1933. The hairy-vetch bruchid, *Bruchus brachialis* Fahraeus, in the United States. Jour. Ag. Res. **46**: 739–51. Apr.

SECTION OF APICULTURE

Qualifications of State Apiary Inspectors

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Reviewing the different qualifications of inspectors of apiaries one finds those who are handling their duties most efficiently and are to be highly commended; their services are inestimable. We also find those working in the capacity of apiary inspectors who are as unfit for such positions as one could imagine, yet through political favoritism they are appointed and the beekeepers are helpless to bring about a change. Happenings of this kind can only hasten untold losses by the continual spread of the brood diseases and eventually causing promising honey, package bee, and queen producing states to go out of business. These disastrous results work slowly but surely and the lamentable thing is that the individual beekeeper, busy with his own affairs, and traveling little through his state, has no knowledge of conditions until too late. If perchance once a year a beekeeper meets with other beekeepers, the program, being arranged perhaps by the apiary inspector, is so taken up with matters of minor importance that at adjournment no one has reviewed the condition of the state from the standpoint of inspections and where the brood diseases have been found.

This condition of affairs will continue until someone takes upon himself the responsibility of bringing about a uniformity of standards for inspection and qualifications essential for the inspectors. If the selection of these inspectors were left with the entomologists and the inspectors worked under their supervision, a step in the right direction would be made. In this case definite standards and qualifications should be followed.

It appears to me that the start should be made in this Section of the

Association, and that a committee be selected to direct attention to this all-important matter. An outline of standardization of inspections, also qualifications of the inspectors, are needed to cope with practices now occurring. The products of the apiary go through intrastate and interstate channels of commerce. Thus a worthless inspector in a state, clothed with authority of issuing spurious inspection certificates, may be the direct cause of not only ruining the bee and honey producing possibilities in a state where such mockery is in progress, but will endanger other states by outgoing shipments of honey, used equipment, and queens.

What has been written above is only leading up to the subject of my paper, which is, "Qualifications of State Apiary Inspectors."

In my opinion, the first essential for the inspector is a good practical knowledge of the life and habits of the honeybee and the principles and practices of modern beekeeping; the inspector should have had some years of experience in caring for bees and success in such operations.

The inspector should be one who has read the standard books in beekeeping and one who is also a careful reader of the beekeeping journals, and the reports of apiary inspection in the United States and Dominion of Canada.

As a third requirement, I would include attendance at the larger state and regional bee keepers' conventions. Acquaintance with beekeepers and their problems is essential. In beekeeping regulatory work as in other types of regulatory service a certain amount of education has to be given. The inspector, therefore, should be able to talk intelligently about the various phases of beekeeping and speak in a direct and forcible manner, giving facts easily understood by the listeners. It is important that he be able to make manipulations and explain each step as he proceeds.

For the inspector to have had a supervised course of study on beekeeping and a course in bacteriology of bee diseases and botany is to be recommended. To entertain this qualification may seem too ambitious, but I question if it is. It is my opinion that the service requires careful training and broad experience. Properly worked out, the whole inspection program should be elevated so that no one except a qualified person should even think of applying for the position of an inspector. The time has come to stop using the position as a political football and for paying political debts. Close state and federal cooperation with a formulated standard is needed. Quarantining a state from making shipments of honey, used bee equipment bees, and queens unless the inspector is qualified and able to take care of the duties of an inspector efficiently might be a means to this end.

In my opinion the inspector should be a person capable of meeting the public in a way that would accomplish best results. In other words, he should be a real friend to those whose bees and equipment have had to be destroyed as well as to those who own apiaries which have been found clean. This requirement might be one most difficult to fulfill, yet upon it depends the cooperation and the highest accomplishments of the inspection service.

If a state does not appropriate sufficient funds to carry on, a charge per colony should be paid by the owner. Little objection will be made

by the beekeeper if the inspector is a competent person who performs his work carefully.

The report should be made in duplicate and the owner given a copy. If American foulbrood is found the clean-up should be done by the inspector and at least two annual inspections should be made. The environs of the infected yard should be inspected, carrying out the area clean-up method. Literature should also be provided that the owner may carefully read it, after the inspector has made his statements and made the clean-up. The reports should be very complete.

The inspector should secure the name and address of every beekeeper in the state with data as to the kind of bees, type of equipment, number of colonies, average yield of honey, whether the owner reads beekeeping journals, and his problems.

In concluding these ideas as to the qualifications, I would sum them all up by saying that only after examination and by actually observing his manipulations in a bee yard should an inspector be selected. The examinations and demonstrations referred to above should be given by those fully competent to do so.

The purpose in giving this brief paper is to bring up some discussion before this Section on the advisability of our chairman selecting a committee to make a further study by states of the inspection methods used and the qualifications of those actually making the inspections, and to formulate a report, outlining a standard for inspections and the qualifications of an apiary inspector, looking toward uniformity, to be discussed at our next annual session.—1-23-37.

Preliminary Report on American Foulbrood

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The majority of New Jersey beekeepers would probably consider American foulbrood their major beekeeping problem. While the total number of colonies infected with the disease is small and the infected areas generally isolated in the suburban districts, beekeepers throughout the state must continuously be on their guard against the disease. This situation is largely due to the large numbers of small beekeepers who are continually moving from centers of dense population into the rural areas. As this situation has existed for some time, there has been a demand for more satisfactory methods of dealing with the disease problem.

Research work on this project has been carried on along two general lines: (1) an effort has been made to find colonies of bees which exhibit some degree of resistance to infection by American foulbrood and (2) a search has been made for a more efficient method for sterilizing infected equipment.

This paper presents the results of two phases of the study which have been completed. They will be considered under their separate heads.

[1] Paper of the journal series, New Jersey Agricultural Experiment Station, Department of Entomology.

Resistance of individual colonies to American foulbrood.—Attention of the beekeeping public is frequently called to instances of apparent resistance of colonies of bees to American foulbrood. Cases where colonies apparently recover from the disease, or instances where a colony fails to contract the disease when other colonies in the same location have contracted the disease, are all too common.

It is only natural to expect that there is a variation in individual colonies in their resistance to the diseases to which they are subjected. Whether these reported colonies actually exhibit a degree of resistance and whether the degree of resistance is great enough to prove of any practical advantage can be determined only by experimentation. To test the resistance of such colonies the New Jersey Agricultural Experiment Station established an apiary in the Pines area of Ocean county, N. J. This apiary was located in a sparsely populated area directly in the pine woods. The honey flows in this area were light, occurring the spring and early summer from blueberry and huckleberry, which allowed colonies to build up, but only rarely produced a surplus. In the period from 1931 to 1935, 14 colonies which appeared to exhibit some resistance to American foulbrood were tested in this yard.

The majority of the colonies tested in this yard were obtained through the cooperation of E. G. Carr, Deputy Bee Inspector, or his assistants, and might be considered in two groups. The first group was made up of colonies which had been inspected and the disease definitely found and the owner given notice to clean up the colony. Later check-up inspection would find these colonies untreated and apparently free from the disease. The second group was selected from badly infected apiaries and was made up of colonies that apparently had not contracted the disease.

The general procedure after the colonies had been placed in the test yard was as follows: The colonies were allowed to remain in their original equipment and an effort made to make these colonies use up their original stores as soon as possible. This could usually be accomplished in the fall of the year or the colony so prepared for winter that its stores would be practically depleted in the spring. Under this management the majority of the colonies developed American foulbrood before their stores were depleted. In the few cases where disease did not develop the resistance of the colony was tested by adding a diseased comb containing honey from an infected colony. From the observations made on the first group of colonies it is evident that the disease was simply buried by a honey flow which occurred after the initial inspection of the colonies. This also is probably true of the second group of colonies as many of them contracted the disease when they were forced to use up the stores in the hive. In the case of the few colonies in the second group that did not contract the disease until after diseased material was added, the apparent resistance in these cases is probably due to non-robbing tendencies of these colonies. While this does not represent true resistance it may well be that the development of these desirable characteristics is the best method of approaching the problem at the present time.

The results obtained in this study do not necessarily prove that the colonies tested did not exhibit some degree of resistance to American foulbrood, but they do definitely prove that the degree of resistance was

not great enough to be of practical value. In the period from 1931 to the present time many additional colonies which were thought to exhibit a resistance to American foulbrood have been under observation by the writer. The results in these cases were similar to those reported in this paper; that is, if a degree of resistance occurred it was not great enough to be of practical value. As it is apparent from our studies that the number of colonies which exhibit a resistance of practical value is very small,

Table 1.—Frequency, field strength and exposure time to which scales of larvae dead from American foulbrood, *Bacillus larvae*, were treated in the field of radio frequency oscillator.

Frequency	Field Strength, Volts per Inch	Time of Exposure in Seconds	Growth of *Bacillus larvae* when Cultured
5×10^6 (5,000,000)	6000	60	Good
	9000	60	Good
	10600	60	Good
	12000	60	Fair
	14150	30	Fair
	17700	15	Fair
10×10^6	6000	60	Good
	9000	60	Fair
	12000	20	Fair
20×10^6	6000	60	Fair
	9000	20	Fair
	12000	20	Fair
	15700	15	Fair
25×10^6	11328	60	Good
	7700	30	Fair
113×10^6	3746	180	Good
	4900	120	Good

our methods of testing are being modified in an effort to devise a reliable method of testing partial resistance of colonies, with the thought that this low degree of resistance can be intensified by breeding.

Lethal effect of radio frequency oscillations to spores of *Bacillus larvae*.—The rather general use of chemical solutions for the sterilization of infected American foulbrood equipment seems to indicate the need for an efficient sterilizing agent for this purpose. As Headlee (1934) found that radio waves were lethal to insects with a relative short exposure time, this lethal agent seemed to offer some possibilities as a sterilizing agent for American foulbrood-infected material. In order to test the lethal effects of these oscillations on the spores of *Bacillus larvae*, scales of larvae dead from American foulbrood were removed intact from the comb by dessicating small pieces of comb for several days in a calcium chloride dessicator. Such scales in a suitable container were then placed in the field of the radio frequency oscillator for treatment. After treatment the scales were macerated in distilled water and cultured according to the methods described by Sturdevant (1932).

Table 1 gives the results of this experiment.

Results.—These results show that radio frequency oscillations of the nature used in these experiments are not lethal to the spores of *Bacillus larvae* when scales of larvae dead from American foulbrood are treated

for various time intervals. It was found in this study that the time intervals could not be greatly increased because of a tendency for the scale material to heat rapidly which caused it to char and burn. In all cases where the exposure time was less than 60 seconds the scale material was ignited and was removed for testing before it was destroyed. The rapid heating of the scale material by radio frequency oscillations used in this experiment would prevent its uses as a sterilizing agent for infected comb material.—1-26-37.

Literature Cited

Headlee, T. J. 1934. Some observations on the effect of radio waves on insects and plant hosts. N. J. Ag. Exp. Sta. Bul. **568.**

Sturdevant, A. R. 1932. Relation of commercial honey to spread of American foulbrood. Jour. Ag. Res. **45**(5):251–85.

Further Contribution to the Study of Pollen Substitutes

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The question of pollen substitutes is very important to beekeepers and in some portions of the world this problem is especially acute. For the review of the literature on the subject readers are referred to the previous publications by the writer (Haydak 1933).

The method and the procedure of the present experiment did not differ from those described previously (Haydak 1936), except that queens were added to the experimental colonies at an earlier date (in most cases on the second day) and a frame with foundation was placed in the hive before young bees were brushed. Fresh weights of the thoraces of the bees also were determined in this experiment.

The data on the development of the bees, their mortality and the brood-rearing activity as well as the quantity and quality of young bees produced by the colonies were obtained.

Foods.—The following foods were tried: soybean flour, soybean meal, peanut meal, and linseed meal; mixtures of cottonseed meal, soybean meal, and linseed meal each with powdered skim milk (20 per cent of the latter by weight). The foods were ground, sifted through a fine sieve, mixed with honey in ratio 1:4 by weight and distributed to the cells of the comb by means of a spatula. The foods, sugar solution and water were given to the bees *ad libitum*. A colony established and kept under the same conditions and provided with a comb containing pollen and honey served as a control.

Results and discussion.—The results of the experiment are presented in fig. 1 and tables 1 and 2.

Examination of the chart shows that the bees from the experimental

[1] Paper 1489 of the scientific journal series of the Minnesota Agricultural Experiment Station. Completion of this project was made possible by coworkers supplied on project 1985, Minnesota Works Progress Administration. Sponsors, University of Minnesota.

colonies developed their bodies at approximately the same rate, except that the increase in weight and nitrogen of the bees given peanut meal and linseed meal foods was somewhat slower. Fresh weights in all cases showed a marked initial drop. This was probably due to the fact that young bees are unable to control the evaporation of water from their bodies as effectively as the older ones (Mellanby 1935).

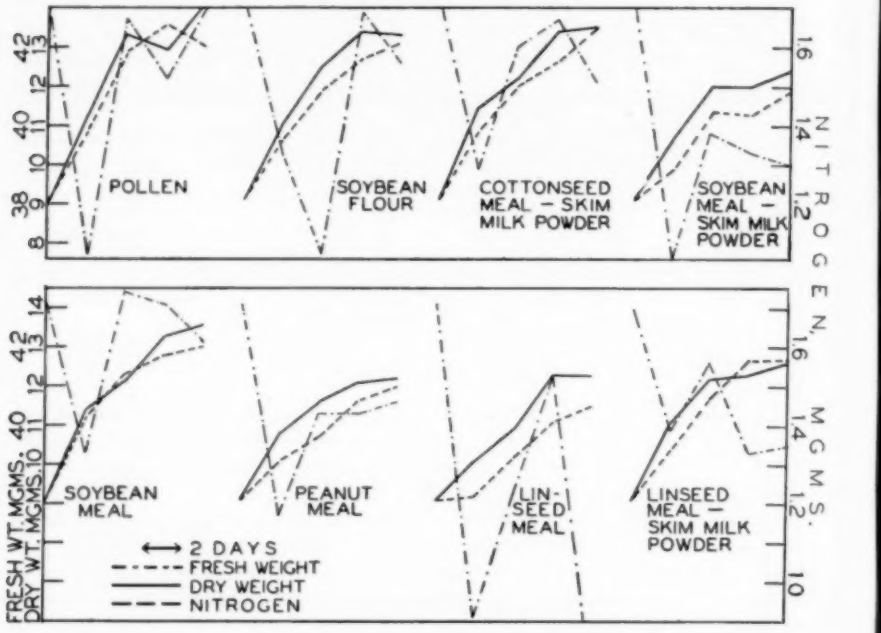

Fig. 1.—Changes in fresh and dry weight and nitrogen content of thoraces of experimental bees.

It is interesting to note that the curves representing the increase in the dry weight and nitrogen content followed each other quite closely. This may indicate that in certain cases the rate of development can be determined by ascertaining only the dry weights of thoraces of the experimental bees.

The lowest mortality was in the control and linseed meal-fed colonies. The latter finding is of interest since linseed meal is noted for its beneficial effects on the digestion in higher animals (Morrison 1936). The mortality in the soybean flour and cottonseed meal–skim milk powder-fed colonies was higher, that in the soybean meal-fed colony was the highest. The mortality of the cottonseed meal–skim milk powder-fed colony quite closely corresponded to the data obtained in a previous investigation (Haydak 1936).

Behavior of the bees in all cages was quite uniform.

Brood rearing activity of the experimental bees varied considerably. Colonies fed soybean flour or mixtures of skim milk powder with cotton-

Table 1.—Composite table of results.

	Pollen	Soybean Flour	Cottonseed Meal, Skim Milk Powder	Soybean Meal, Skim Milk Powder	Soybean Meal	Peanut Meal	Linseed Meal	Linseed Meal, Skim Milk Powder
				No. Bees per Colony				
	6279	3892	7014	3433	7070	7174	6465	7086
				Age of Old Bees Taken for Determination of the Weight and Nitrogen, Days				
	21	21	28	21	36	42	27	36
				Average Dry Weight of Thoraces, Mg.				
8 Days	14.2	13.3	13.5	12.4	13.6	12.2	12.3	12.6
Old Bees	13.1	13.9	13.4	12.8	14.6	13.1	13.4	
				Weight Increase over Emerging Bees, Per Cent				
8 Days	56	46.2	48.4	36.3	50	34.1	35.2	38.5
Old Bees	44	52.8	47.3	40.7	60.4	44	47.1	
				Average Nitrogen Content per Thorax, Mg.				
8 Days	1.6	1.61	1.65	1.49	1.6	1.5	1.45	1.57
Old Bees	1.63	1.66	1.6	1.46	1.64	1.65	1.58	
				Nitrogen Increase over Emerging Bees, Per Cent				
8 Days	32.2	33.1	36.4	23.1	32.2	24	20	30
Old Bees	34.7	37.2	32.2	20.7	35.5	36.4	30.6	
				Percentage Mortality				
	19.3	30.2	28.2	42.6	44.5	28.6	18.1	20.3
				Brood Rearing Activity				
	Produced young bees	Produced young bees	Produced young bees	Produced young	Hatched to sealed larvae	Hatched to ½ day-old larvae	Hatched to 2½ day-old larvae	Hatched to sealed larvae
				No. Sealed Cells and Larvae Before Sealing				
	1558	248	244	351	0	0	0	0

seed meal or soybean meal reared brood normally, although the number of the sealed cells and larvae just to be sealed was smaller than that in the control colony. Moreover, the sealed cells in the latter colony formed a compact mass, whereas in the other three colonies there were cells containing either eggs or very young larvae among those sealed. The cottonseed meal–skim milk powder-fed colony was somewhat slow in starting normal brood rearing activity, first sealed cells being found on the eleventh day after the first hatched larvae were noticed. Whether this was due to the removal of those larvae or to their slower development was not established. However, it is quite probable that this was due to the former cause. The presence of cells containing eggs or very young larvae among those sealed may indicate that.

For 10 days only eggs were present in the soybean meal-fed colony.

Table 2.—Dry weight and nitrogen content of emerging bees.

Food	Dry Weight, mgms.				Nitrogen per Bee, mgms.			
	Head	Thorax	Abdomen*	Whole	Head	Thorax	Abdomen*	Whole
Normal in confinement	2.6	9.6	2.7	18.6	.28	1.14	.28	2
Soybean flour	2.4	9.2	2.5	17.2	.26	1.09	.26	1.96
Cottonseed meal–skim milk powder	2.8	9.3	3.2	16.8	.28	1.07	.31	1.9
Soybean meal–skim milk powder	2.3	7.8	2.8		.25	.88	.23	

* Intestines were removed from abdomens before weighing.

When the queen was removed, hatched larvae appeared. The royal jelly was of a watery consistency. Five queen cells were built by the bees. The comb with the queen cells was taken to the constant temperature chamber. No queen emerged. A new queen was added to the colony. The bees commenced to rear brood but only few larvae were growing and there was considerable lack of food in the cells with larvae. Only three sealed cells were observed which were opened by the bees and the larvae were apparently removed. For 36 days the bees were fed the soybean meal diet (in this as in the following cases the first seven days were not counted) and were unable to rear brood normally.

For 15 days there were no hatched larvae in the peanut meal-fed colony, although there was an abundance of eggs present. Only when the queen was removed, hatched to one-half day-old larvae could be found in the cells with a scarcity of food. A queen cell was built over one about 3 day-old larva which was unhealthy in appearance. This larva was later removed by the bees. When a queen was again introduced, for 15 days only eggs were present in the cells. For 43 days bees were given opportunity to rear brood on the peanut meal diet and were unable to do that.

When it was noticed that for 12 days only eggs were present in the linseed meal-fed colony, the queen was removed. No hatched larvae were found and no queen cells were built by the bees. When a queen was added again. for 12 days only hatched to $2\frac{1}{2}$ day-old larvae were seen in the cells. For 28 days the bees were kept on this diet and were unable to rear brood normally.

The linseed meal–skim milk powder-fed colony did not have any hatched larvae for 14 days. After the queen was removed the bees started brood rearing, but for seven days only one to $1\frac{1}{2}$ day-old larvae were present in the cells. Finally only two unhealthy larvae remained. In spite of an abundance of the larval food in the cells with the larvae, the latter were not growing. When the queen was added anew, many hatched to $1\frac{1}{2}$ day-old larvae and few $2\frac{1}{2}$ day-old larvae were found in the cells. Later one sealed cell and a larva just to be sealed were noted, but no sealed cell or larva were found during the following examination. For 36 days the bees were unable to rear brood normally.

In order to ascertain whether or not the bees in the broodless colonies would be able to rear brood on the normal food, a comb with pollen and honey from an outside colony was placed into each of the four experimental colonies which were unable to rear brood on pollen substitutes.

Although the number of bees in soybean meal and peanut meal-fed colonies was considerably reduced, the bees started to rear brood six days after pollen was given to them and continued their brood rearing activity normally.

After the diet of the linseed meal-fed colony was changed to pollen, for 20 days only hatched to $2\frac{1}{2}$ day-old larvae were seen in the hive. On the twenty-eighth day, four sealed cells were observed and about 20 hatched to $2\frac{1}{2}$ day-old larvae were present in the cells.

When a comb with pollen was added to the linseed meal–skim milk powder-fed colony only hatched to $1\frac{1}{2}$ day-old larvae were seen in the cells for a period of 16 days.

The data obtained from the last two colonies suggest that the presence

or deficiency of some factor or factors inhibited the normal brood rearing and that such factor or factors have a pronounced influence on the bee organism.

The normal development of the young bees in the experimental colonies indicates that they were able to digest and to utilize all the foods studied. The inability of some colonies to rear brood normally cannot be explained on the basis of the chemical composition of the foods used in the experiment. Proteins of soybean, peanuts and linseed contain all the essential amino acids and their nutritive value, especially that of

Table 3.—Percentage composition of foods.*

	Pollen	Larval Food	Soybean Meal	Peanut Meal	Linseed Meal	Cotton-seed Meal
Water	7.66	24.15				7.8
Protein	16.6	30.62	44.3	42.7	35.2	39.8
Fats	10.63	15.22	5.7	8.5	6.3	8.3
Carbohydrates	16.24	14.05	30.3	27.	36.3	27.4
Ash	3.3	2.34	5.7	6.3	5.5	6.6
Calcium	.02		.28	.17	.33	.265
Magnesium	.14		.25	.22	.53	.462
Potassium	.96		2.2	1.16	1.27	1.39
Sodium	.09		.51	.07	.11	.234
Phosphorus	.43	.67	.66	.55	.86	1.193
Chlorine	.03		.04	.03	.05	.037
Sulfur	.2	.38	.45	.21	.38	.485
Cystine	.51	3.78	1.18	1.08	1.1	.9
Hystidine	.41	1.74	2.1	1.88	6.1	7.2
Lisine	.97	4.41	9.06	4.98	3.7	4.2
Tryptophane			1.66	.88		
Vitamins	B	AB	BG	BG	E(BG?)	ABG

* The sources of data for this table were given in the previous publication by the writer (Haydak 1936). Exception is Morrison's "Feeds and Feeding," 1936.

soybeans, is very high (Hayward, Steenbock & Bohstedt 1936a, 1936b; Morrison 1936). The mineral content of the foods appear to be satisfactory. Vitamins of the B type are present in soybeans and peanut meal. However, there is no conclusive evidence on the vitamin B content of linseed meal. It is probable that some other unknown factors or lack of them prevented the normal brood rearing activity of the experimental bees.

Young bees reared by the colonies were normal. The dry weight and the nitrogen content of the bees produced by the soybean meal–skim milk powder-fed colony was the lowest. The greatest number of bees was reared by the control colony.

The building activity of the experimental bees was normal in all the colonies.

Conclusions.—Bees can develop their bodies normally when fed soybean flour, soybean meal, peanut meal, linseed meal, or soybean meal, linseed meal and cottonseed meal, each mixed with powdered skim milk, 20 per cent by weight.

The lowest mortality was observed in the linseed meal-fed colony, the highest in that which had soybean meal for food.

The behavior was normal in all the experimental colonies.

Only those colonies which had pollen, soybean flour, soybean meal or cottonseed meal both mixed with skim milk powder produced young bees. The largest number was reared by the control colony.

The young bees produced by the colonies which reared brood were normal, but those produced by the soybean meal–skim milk powder-fed colony had the lowest weight and nitrogen content.

Building activity was normal in all the colonies.

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Literature Cited

Haydak, M. H. 1933. Der nahrwert von pollenersatztoffen bei bienen. Arch. F. Bienenkunde **14**:185–219.

Haydak, M. H. 1936. Value of foods other than pollen in nutrition of the honeybee. Jour. Econ. Ent. **29**(5):870–7. Oct.

Hayward, J. W., H. Steenbock and G. Bohstedt. 1936a. The effect of heat as used in the extraction of soybean oil upon the nutritive value of the protein of soybean meal. Jour. Nutr. **11**:219–34.

Hayward, J. W., H. Steenbock and G. Bohstedt. 1936b. The effect of cystine and casein supplements upon the nutritive value of the protein of raw and heated soybeans. Jour. Nutr. **12**:275–83.

Mellanby, K. 1935. The site of loss of water from insects. Proc. Roy. Soc. London, B, **116**:130–49.

Morrison, F. B. 1936. Feeds and Feeding. Ithaca, N. Y. 1050 pp.

Alleged Vitamin E Content in Royal Jelly

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Food of the honeybee, *Apis mellifica* Linn., is rather generally believed to contain some substance or stubstances which under proper conditions will cause young worker larvae to develop into queen bees. This food when fed to queen larvae is known as royal jelly. The fact that worker larvae in worker cells develop into worker bees instead of queens is supposedly explained by the size of the cell and by the kind and quantity of food administered by the nurse bees. That either a worker or a queen larva may come from the same egg is an established fact, easily demonstrated in rearing queens. As can also be demonstrated, normal worker larvae more than three days old cannot be converted into queen bees. Evidently, therefore, worker and queen larvae must have similar organic development during the first three days of larval life.

The few incomplete analyses available on the food of worker larvae and of queen larvae indicate a similarity in the chemical constituents of both during the early part of larval feeding; but later a considerable

change apparently occurs in the food of the worker larvae. The food of queen larvae is fairly constant chemically throughout the feeding period, the greatest variation occurring in the water content.

This brood food or royal jelly is secreted by the pharyngeal glands of nurse bees. It is elaborated from honey and pollen, although sugar sirup may be substituted for honey. As Haydak (1935) has shown, bees may produce larval food for one to two weeks without having access to pollen;

Table 1.—Data relating to the materials used and results obtained in the first test of vitamin E in royal jelly.

Sample Royal Jelly	Rat No.	Born	Positive Mating	Erythrocyte Sign	Isolation	Result
2 Day	W1459	1/ 2/36	4/10/36	4/22/36	4/30/36	resorbed
1.05 gm.	W1497	1/ 2/36	4/14/36	4/27/36	5/ 4/36	resorbed
3 Day	W1567	1/ 2/36	4/14/36	4/27/36	5/ 4/36	resorbed
1.05 gm.	W8243	12/12/35	4/15/36	4/28/36	5/ 5/36	resorbed
	W1569	1/ 2/36	4/16/36	4/27/36	5/ 6/36	resorbed
2.10 gm.	W8101	12/12/35	4/21/36	5/ 4/36	5/11/36	resorbed
	BH6572	11/28/35	4/21/36	5/ 4/36	5/11/36	resrobed
	W1562	1/ 2/36	4/21/36	5/ 4/36	5/11/36	resorbed
4 Day	BH 1512	1/ 2/36	4/ 8/36	4/21/36	4/28/36	resorbed
1.05 gm.	W1563	1/ 2/36	4/ 8/36	4/21/36	4/28/36	resorbed
	BH1493	1/ 2/36	4/ 8/36	4/20/36	4/28/36	resorbed
2.10 gm.	GH6586	11/29/35	4/ 7/36	4/20/36	4/27/36	resorbed
	BH6562	11/28/35	4/ 8/36	4/21/36	4/28/36	resorbed
	BH6574	11/28/35	4/ 9/36	4/22/36	4/29/36	resorbed
	W1564	1/ 2/36	4/17/36	4/30/36	5/ 7/36	resorbed

but in so doing they deplete the nitrogen reserve in their body cells. Thus the glandular origin of this food is quite clearly demonstrated.

In 1932 Hill & Burdett (1932) reported the presence of vitamin E in royal jelly. The test animals used in their experiments were presumably depleted of vitamin E as adults, after the casting of a first litter on a normal diet. Litters were obtained from two rats that had received a daily dose of .05 gm. of royal jelly for about five weeks. No sign of fertility (except one dead fetus) was observed in four rats fed on vitamin E-free diet plus 2 gms. of honey and pollen daily for two months. One of the rats also received 2 gms. of worker-bee larvae in the comb in addition to her vitamin E-free diet. From these last tests Hill & Burdett (1932) inferred that bees add vitamin E to royal jelly, on which the queen larvae are reared, and withhold it from food of worker larvae.

Further feeding experiments with royal jelly were continued by Hill & Burdett (1933), the rats being handled presumably the same as in 1932; but results indicated that the methods used had not depleted the rats of vitamin E. Some doubt, in consequence, is cast on the accuracy of the previous results. The royal jelly fed by Hill & Burdett was obtained from "old queen cells" in colonies at time of swarming. The age of the royal jelly may have varied from three to 10 or 12 days.

Further experimental determinations.[1]—An attempt was made at the University of California during the summer of 1936 to determine whether royal jelly could function as vitamin E when fed to female rats of proved sterility. The test rats were used only after their sterility had been manifested by their having had a resorption gestation. We feel that the age of the test animals is highly important. Our experience has shown that in old animals no amount of wheat-germ oil (high in vitamin E) will restore fertility. We employed, therefore, only female rats under six months of age. These rats were placed on the vitamin E low diet at 21 days. Diet 427, which was used, consisted of the following ingredients: commercial casein, precipitate with HCL, 27 per cent; cooked cornstarch 35 per cent; salts [McCollum 135 (McCollum & Simmonds 1918)] 4 per cent; lard 22 per cent; cod-liver oil 2 per cent; brewer's yeast 10 per cent.

Table 2.—Data relating to the materials used and the results of ether-soluble extract of royal jelly for vitamin E (.432 gms. = 9 gm. of royal jelly).

Sample Ether-soluble Extract	Rat No.	Born	Positive Mating	Erythrocyte Sign	Isolation	Result
.432 gm.	GH7232	5/21/36	9/15/36	9/28/36	10/5/36	resorbed
.432 gm.	BH8647	6/ 4/36	9/15/36	9/28/36	10/5/36	resorbed
.432 gm.	W5718	5/ 7/36	9/16/36	9/29/36	10/6/36	resorbed

The ingredients (excepting the cod-liver oil) were allowed to stand at room temperature for two weeks. The cod-liver oil was added just before feeding. Thus the vitamin E present in the diet is destroyed by the incipient rancidity of the lard.

The rats were placed with normal males at the first pro-oestrus after 60 days and were observed for positive mating, for the erythrocyte sign (indicating implantation), and for the typical gain and gradual loss of weight of a resorption gestation. The animals were then ready for use as test animals. The uniformity of the rats is tested from time to time by an assay of wheat-germ oil prepared and kept under carefully controlled conditions. A standard test animal is enabled to bear young by the administration of 500 mgs. of our wheat-germ oil.

Royal jelly.—The royal jelly used in these experiments was secured from cells produced in the university apiary by transferring worker larvae under 24 hours of age into artificial queen-cell cups. After the second, third and fourth days the larvae were removed from the first series of transfers, and the cells sealed with wax cups to prevent evaporation. The cells were held under refrigeration to reduce any chemical change that might take place. For the succeeding experiments the royal jelly was taken from the cells the third day after transference and kept in closed vials under refrigeration until used.

[1] Schoorl (1936) reports the results of an attempt to assay royal jelly for its vitamin E content. The results were inconclusive, as some rats failed implantation, one littered (possible contamination from cage partners receiving wheat-germ oil), and three rats resorbed. As the royal jelly was mixed with the diet in some cases and subjected to possible destruction of vitamin E potency thereby, no definite conclusion was reached. (This reference was not available until after the present paper had been completed.)

Methods and materials used in feeding.—In the first experiment the sealed cells were opened; the royal jelly was removed, weighed, diluted with distilled water and fed within one-half hour from the time of opening the cells. The royal jelly was diluted with an equal quantity of water, and feeding was accomplished with a syringe, a fine silk catheter (fitting a No. 20 needle) serving as stomach tube. Larger quantities could not well be fed by this means because the jelly tended to cement the plunger. All samples were fed under light ether anaesthesia on the day of positive mating.

Because of the difficulty encountered in feeding large quantities of royal jelly as such, the fat-soluble material was extracted in a manner known to remove any vitamin E present.

Table 3.—Data relating to the feeding of royal jelly and of pollen when mixed with sucrose and water.

Sample Ether-soluble Extract	Rat No.	Born	Positive Mating	Erythrocyte Sign	Isolation	Result
10 gms.	BH2579	7/ 2/36	10/20/36	11/2/36	11/ 9/36	resorbed
10 gms.	BH2571	7/ 2/36	10/20/36	11/2/36	11/ 9/36	resorbed
10 gms.	BH2593	7/ 2/36	10/20/36	11/2/36	11/ 9/36	resorbed
4.45 gms.	BH2592	7/ 2/36	10/20/36	11/2/36	11/ 9/36	resorbed
5 gms., pollen	BH1186	6/18/36	10/22/36	11/4/36	11/11/36	resorbed
5 gms., pollen	G1267	6/18/36	10/22/36	11/4/36	11/11/36	resorbed
5 gms., pollen	W4089	7/16/36	10/22/36	11/4/36	11/11/36	resorbed
5 gms., pollen	BH2588	7/16/36	10/22/36	11/4/36	11/11/36	resorbed

Three-day royal jelly was dried by triturating with six lots of acetone. After the first and second grindings, the material was a sticky mass, but after further treatment a fine, sandlike, granular powder remained. The combined acetone washings were concentrated, diluted with distilled water, and extracted four times with peroxide-free ether. The residual royal jelly was also subjected to three ether extractions. The ether extracts were combined, and the solvent was removed. The fat-soluble material comprised 4.8 per cent of the original royal jelly. This fraction was dissolved in ethyl laurate and assayed for its vitamin E potency.

In the last set of experiments the royal jelly was fed mixed with sucrose and water to rats offered no other food. The 10 grams were not consumed completely until after 48 hours' starvation. Five-gram samples of pollen from the comb were fed in a like manner.

Discussion.—As shown by the data presented in tables 1, 2 and 3, no vitamin E activity was manifested when royal jelly, its fat-soluble fraction, or pollen from the comb was fed to young, female rats of proved sterility. The results are highly significant, since the quantities of royal jelly fed were far greater than previously reported by other workers.—5-4-37.

Literature Cited

Burdett, E. F. 1933. Vitamin E brood food research. Bee World **14**(12):134–5.

Haydak, Mykola A. 1935. Answer to a disputed question. Gleanings Bee Cult. **63** (4):211. Apr.

Hill, Leonard and E. F. Burdett. 1932. Fertility of bees and vitamin E. Nat. **130**:540.
McCollum, E. J. and N. Simmonds. 1918. A study of the dietary essential, water-soluble B, in relation to its solubility and stability towards reagents. Jour. Biol. Chem. **33**:55–89.
Schoorl, P. 1936. Vitamin E research. Zeitschrift fur Vitamin forschung **5**(4):246–53. Oct.

Relation of Size to Fecundity in Queen Honeybees

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Numerous attempts have been made to find some standard of measurement which might be used as a reliable index to the reproductive capacity of queen honeybees. If such an index were found, it would mean that the body measurement used was highly correlated in some manner with reproductive capacity. An index of this type would greatly simiplify investigations of fecundity in the honeybee. At present the only known method is to judge this factor after observing the performance of a queen, as indicated by her brood production and by the work of her colony, over a period of one or more seasons. A more thorough method is to test in this manner not only the queen in question but also a number of her daughters. Obviously, neither method sets up definite standards of measurement; and each entails a delay in selecting a breeding queen, besides shortening the useful period over which a good queen can be used for queen-rearing purposes.

The habits of the honeybee in mating make for some uncertainty in evaluating various physical characters of queens in terms of potential worth. Until more is known about the probable relation of physical factors to performance, however, even the application of controlled mating to a solution of this question will be materially retarded.

In a previous paper the writer (1934) reported data indicating an apparent tendency for the number of ovarioles in queen bees to be influenced by hereditary factors. The age of the larva at the time of transforming was also shown to have no significant effect on the number of ovarioles in 49 queens reared from larvae of different ages. And, further, no significant correlation was found between the body size and the number of ovarioles in 50 queens reared from the same queen mother or in 83 queens of the same general strain.

Additional determinations.—During a study of external morphological characters in relation to the number of ovarioles in queen bees, the fecundity of the queens was measured by determining the number of square inches of sealed brood found in the colonies before the queens were dissected. The methods of determining body size and the number of ovarioles were the same as those described in the previous paper. The queens were reared under conditions and methods comparable with those included in the data reported earlier.

The number of square inches of sealed brood in each colony was determined by actual count from negatives made of the brood combs. Each

queen was introduced into a normal colony and allowed several weeks in which to develop a normal brood nest. Brood counts were taken near the close of the spring honey flow. Two brood records were planned for each queen with an interval of several weeks between the series of photographs. The colonies were, however, seriously affected by drifting poisons after the promiscuous broadcasting of calcium arsenate over tomato fields by airplane; all experimental records, indeed, were nullified after the first applications took effect. This damage occurred in both years, 1935 and 1936, in which these tests were made.

Table 1.—Frequency distribution of the number of ovarioles and the square inches of sealed brood for 38 queens.

Square Inches of Brood

Number of Ovarioles	200	225	250	275	300	325	350	375	400	425	450	475	500	525	550	575	600	625	650	675	700	725	750	775	800	825	F
295																				1							1
300						1										1	1										3
305																			1								1
310																											0
315																											0
320																											0
325	1											1								1							3
330									1				1		1		1	1	1							1	7
335				1						1		1							1								4
340										1				1													2
345														1	1												2
350																1											1
355										2				1				1									4
360				1							1																2
365										1			1		1		1		2								6
370						1																					1
375																											0
380																											0
385																											0
390																											0
395																1											1
F	1	0	0	2	0	2	0	0	1	5	1	2	2	3	3	3	3	2	5	2	0	0	0	0	0	1	38

Although measurements of only 38 queens and their brood counts were completed, the results are given here to indicate the value of certain morphological characters in judging the potential possibilities of a queen honeybee.

Results.—In the first correlation, between the size of the forewings and the number of square inches of brood, the mean length of forewings was $9.98 \pm .028$ mm., whereas the mean number of square inches of sealed brood was 519.59 ± 14.85. The coefficient of correlation was $-0.41 \pm .110$, indicating no evidence of correlation between these factors in the queens examined. A somewhat similar result was obtained in correlating the length of femurs with the square inches of brood.

The frequency distribution in table 1 indicates the wide variation in the number of square inches of brood in connection with the number of ovarioles in the queens studied.

The same queens had a mean number of 340.5 ovarioles. The coefficient of correlation for the number of ovarioles and the square inches of brood was $-.086 \pm .034$. indicating no correlation between these factors.

A summary of the measurements of 162 queens of various Italian strains dissected by the writer gave a mean length of forewings of 9.78 mm., a mean number of 337.8 ovarioles, and a coefficient of correlation of $.138 \pm .002$. This coefficient is significant but it is too low to have any

practical value as an index of the number of ovarioles. It cannot be used as an index of fecundity since no correlation has been established between the number of ovarioles and fecundity.

Discussion.—The results of these studies indicate that the body measurements of the queen that were studied cannot be used as criteria of fecundity. The results are of further significance in that they indicate but little correlation between the development of the external parts and of the internal characters studied. Evidently, therefore, other factors must be included with these values in future studies of this problem.

Our studies would justify the suggestion that one might find a definite correlation between such characters as external size and the total development of the ovaries in queen honeybees if one could gauge accurately the size of ovaries by their length or weight as well as by the number of ovarioles. These factors are influenced by many physiological conditions as well as by unmeasurable environmental entities. The use of a greater number of individuals in determining the relation between the size of ovary and brood production and the use of an average of a series of brood counts over a longer period might be expected to smooth out certain errors that are magnified in importance when one is dealing with the number available in the present studies.—5-15-37.

Literature Cited

Eckert, J. E. 1934. Studies in the number of ovarioles in queen honeybees in relation to body size. Jour. Econ. Ent. **27**(3):629–34. June.

EASTERN BRANCH

PAPER-READING SESSION, EIGHTH ANNUAL MEETING

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Semicommercial Manufacture of Nicotine Peat

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Nicotine peat, a new type of nicotine insecticide in which the alkaloid is substantially insoluble in water, was recently described (Markwood 1936a). This product is formed when nicotine and peat are brought together in the presence of water. A companion product, formed in the same reaction and known as "nicotine humate," has also been described (Markwood 1936b). The latter compound is soluble in water.

The original process for making nicotine peat calls for the separation of the soluble from the insoluble reaction product, to obtain a compound of maximum nicotine insolubility. Desirable though this separation is for the purpose expressed, it is an appreciable item in the cost of manufacture.

It has been found that a satisfactory product can be obtained by

omitting this separation, with consequent simplification of the process. This shortening is possible because only a small part of the nicotine is converted to humate, the major part being in the insoluble form.

A program of field tests with nicotine peat for the control of the codling moth on apple trees was outlined for the season of 1936. The estimated requirement was 400 pounds. To meet this requirement it was decided to prepare two types, one from acid-treated New Jersey reed peat, which furnished the product of lowest nicotine solubility, and the other from German moss peat, which is the best of the untreated peats (Markwood 1936a).

Manufacture from New Jersey reed peat.—It had already been learned that to treat commercial shipments of New Jersey peat with acid, the peat, which has a moisture content of 65 per cent, must first be dried to about 10 per cent moisture (Markwood 1937).

The facilities of a commercial plant were engaged for manufacturing purposes. A small-sized rotary vacuum dryer, 42 by 18 inches, was used for drying the peat. The dryer is of double-wall construction for heating by steam and is fitted with a rotating spiral agitator, which slowly turns over and thoroughly mixes the contents. A high-vacuum pump draws off the vapors to a condenser.

Before the peat was loaded into the dryer, it was passed through a 5-mesh screen to remove stones and lumpy matter. A typical run was as follows: A charge of 100 pounds of damp peat was placed in the dryer and heated at 10–15 pounds steam pressure for 3½ to 4 hours under the full suction of the pump. At the end of this time the moisture content had been reduced to 10 per cent of the residual weight and the material felt quite dry. It had also shrunk considerably in volume. The density of the material was increased from 37 to 40 pounds per cubic foot. About 35 pounds of dried peat resulted, and it issued from the dryer in sufficient fineness (about 60 mesh) to require no grinding for the next operation, the acid extraction.

Table 1.—Analyses of nicotine peat made on a semicommercial scale.

Determination	New Jersey Product pH 4.2 per cent	German Moss Product pH 6.3 per cent
Total nicotine	10.6	9.37
Water-soluble nicotine*	1.29	2.96
Insoluble nicotine	9.31	6.41
Insoluble nicotine as percentage of total	88	68
Moisture	8.3	5.24
Ash	9.84	25.06
Screen Analysis†		
Coarser than 100 mesh	1	15
100–150 mesh	8	33
150–200 mesh	66	22
Finer than 200 mesh	25	30
Total	*100*	*100*

* Based upon dilution to .05 per cent nicotine.

† The German moss product was wet-screened with acetone, as the dry powder would not pass through the sieves. The figures are to be considered only approximate.

The peat was extracted with hydrochloric acid for removal of the calcium and other bases. This operation was conducted in a 50 gallon paraffin-lined wooden barrel. The peat was allowed to soak in a 2 per cent solution of hydrochloric acid for about 24 hours with frequent stirring. Most of the liquid was then drawn off by suction through a canvas-covered filter disk, and the residual peat mud was similarly washed with two or three changes of water. There was still an appreciable amount of hydrochloric acid in the mud, but this was readily and completely removed after several minutes washing in a basket-type centrifuge. The

material to be washed was placed in the canvas bag fitting the perforated basket, with a heavy wire screen between the canvas and the metal wall to facilitate drainage. A continuous stream of water was directed against the whirling layer through a wide-angle nozzle until the effluent water showed no test for chloride, or at least no stronger a test than the wash water itself. A test for acidity with litmus paper was also made, but allowance had to be made for the natural acidity of the peat, which is strong enough to color litmus a dull red. The pH of this acid-treated peat is 2.4, as compared with 5.1 for the untreated peat. The material as it came off the centrifuge carried 50 to 60 per cent moisture.

The same rotary dryer was used as the reaction vessel for the reaction with nicotine. The charge consisted of 56 pounds of peat (dry basis), 15 gallons of water and 8.5 pounds of commercial 95 per cent nicotine. This amount of water made a moderately thick slurry, and the nicotine was calculated to make about a 10 per cent product. The mixture was heated under a reflux arrangement to 180° F, which required about 15 minutes. The steam was then turned off and the pump gradually turned on. Heating up to 40 pounds of steam followed under full suction for five to six hours, after which time the product was deemed dry enough.

To shorten the time required for drying, as much of the liquor as possible might be drawn off after the reaction and before drying. The liquor could then be used in a succeeding reaction. This would give a product of somewhat lower nicotine content but of lesser nicotine solubility. If it is desired to keep up the nicotine content, the initial charge of nicotine can be increased to compensate for the amount drawn off.

A total of 330 pounds of nicotine peat was produced in this way in seven runs. It was fairly fine, 80–100 mesh, but not fine enough for spraying. It was therefore gound, as described later.

Manufacture from German moss peat.—Nicotine peat from German moss peat was made in a similar way except that there was no acid treatment. The pH of this peat is 3.7. It is purchased in 150-pound bales and carries about 30 per cent moisture. It is very bulky, having a density of 5 pounds per cubic foot. A single charge in the dryer consisted of 13 pounds of peat, 18 gallons of water and 2 pounds of commercial 95 per cent nicotine. This peat requires considerably more water to form a slurry then the denser New Jersey type. A somewhat higher ratio of nicotine to peat was used in this case, the amount taken being enough to form a 13 per cent product. The mixture was heated as before to 180° F and held at this temperature for 15 minutes. The steam was then shut off, suction gradually applied, and the steam again turned on for the drying under reduced pressure. After $4\frac{3}{4}$ hours heating the material was of adequate dryness. The total quantity produced was 95 pounds in seven runs. This material had about the same degree of fineness as the New Jersey product.

Grinding.—To bring both these products to a state fine enough for spraying it was necessary to grind them in a mill. A pebble mill was used, equipped, unfortunately, with soft stones, which were worn down to add to the ash, or inert constituents, of the product. This was not serious as far as the New Jersey product was concerned; it was ground for 16 hours

and gained less than 2 per cent in weight. The German product, however, had to be ground 48 hours, chiefly on account of its fibrous nature, and it picked up about 33 per cent of its weight in ash. The grindings were passed through a 40-mesh screen before being packed in tins.

Analyses.—Analyses of the products are given in table 1.

Summary.—The semicommercial manufacture of nicotine peat from New Jersey reed peat and German moss peat is described. New Jersey peat is screened for the removal of impurities, dried to a moisture content of 10 per cent, soaked in 2 per cent hydrochloric acid, washed free of soluble matter, and then treated with nicotine in the presence of water. The mixture is dried and ground to a fine powder. German moss peat is treated directly with nicotine. Analyses of the two products are given. The nicotine content is about 10 per cent and the nicotine insolubility is 88 per cent of the total for the New Jersey product and 68 per cent for the German product. Standard commercial equipment, including a vacuum dryer and a centrifuge, was used.—2-25-37.

Literature Cited

Markwood, L. N. 1936a. Nicotine peat. A new insoluble nicotine insecticide. Indus. & Engin. Chem. **28**(5):561–3. Illus.

Markwood, L. N. 1936b. A new water-soluble nicotine insecticide—nicotine humate. Indus. & Engin. Chem. **28**(6):648–9. Illus.

Markwood, L. N. 1937. A commercial process for de-basing peat. (Submitted for publication.)

Control of Oyster-shell Scale on Apple

By Means of Tar Oils, Tar-Lubricating Oils, and Lubricating Oils Containing Dinitro-o-cyclohexylphenol

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Orchard experiments made with tar–lubricating oil emulsions during 1932 and 1933 indicated that these materials were very effective in controlling the oyster-shell scale, *Lepidosaphes ulmi* L., on apple. However, at that time all the commercial emulsions used contained tar oil and petroleum oil in different proportion so the results need not be considered here. Opportunity was afforded during 1936 to test, on apple trees infested with oyster-shell scale, emulsions of (1) coal-tar oil, (2) coal-tar oil and lubricating oil, (3) water-gas tar oil, (4) water-gas tar oil and lubricating oil, and (5) lubricating oils containing dinitro-o-cyclohexylphenol. The latter compound, for brevity, will be designated DNOCHP and the mixtures as DNOCHP-oils. Lubricating oils alone were not tried for the following reasons: (1) It has long been conceded by entomologists

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that petroleum oils are not very effective against this pest; (2) most of the infested trees were considered to be too weak to tolerate higher concentrations of lubricating oil, which left only a limited number of more vigorous, infested trees upon which the tests could be made; (3) since a choice had to be made between either limiting the experiments with DNOCHP-oils and adding a series of different concentrations of lubricating oil or carrying out the series of DNOCHP-oils and eliminating the tests with lubricating oil, the latter alternative was chosen for the first reason given.

It should be clearly noted that all the tests were on the *apple form* of the oyster-shell scale on apple and that the results should not be interpreted as applying to this form on other kinds of trees nor to the *lilac form* of this species. Experiments by Dr. F. L. Gambrell of this station have shown that the latter form is not controlled, on lilac at least, by

Table 1.—Composition and dilution of brands consisting of lubricating oil and dinitro-o-cyclohexylphenol.*

Brand	Per Cent Oil	Per Cent DNOCHP	Per Cent Emulsifier	Per Cent Concentration of Oil in Spray Mixture
A	75	3	22	3, 4 and 6
B	81	4	15	4 and 5
C	96	4	0	4 and 5

* These brands were manufactured by the Dow Chemical Company, Midland, Mich.

coal-tar oils. The other materials discussed in this paper have not been tested on this probable variety of the oyster-shell scale.

Materials and mixtures.—The coal-tar oils used were three brands of commercial emulsions which the manufacturers claimed contained refined straight-run creosote oil, following the specifications given by Hartzell, Harman & Reed (1935). Since the effects on oyster-shell scale, at the same dilutions of tar oil, were practically the same for each brand the results have been combined in table 3. The water-gas tar oil had a distillation range similar to the coal-tar oil and was emulsified in the tank by using 1 pound of a commercial lignin pitch powder (*Goulac*) in each 100 gallons of spray mixture. The lubricating oil met the specifications given in the paper cited above. The composition of the several brands of DNOCHP-oil is given in table 1.

Description of experiments.—Severe infestations of oyster-shell scale in apple orchards are uncommon in western New York. Near Geneva, however, an orchard was found in which about half of the trees varied from light to severely infested. Of these, 84 trees were either treated or used as checks. The several varieties had been interplanted so that of the infested trees there were 43 Rhode Island Greening, 33 Twenty Ounce, six Sutton and two Rome Beauty.

Coal-tar oil emulsions were used to a larger extent than the other materials because of the weakened condition of most of the trees and the fact that coal-tar oils are safer than lubricating oils on such trees. Concentrations of the ingredients in the mixtures used are given in table 3.

Spraying was done on April 9 and 10 and a single application was given each treated tree. At this time the buds were swollen, but none had

reached the silver-tip stage. A modern spray rig was used which maintained a constant pressure of 350 pounds with two spray guns. The spray men operated from the ground, and the plats were arranged to avoid spray drift from adjacent plats.

Method of securing and analyzing data.—An attempt was made in May to secure data by taking samples from the trees and counting the apparently dead and living eggs. These results were fairly accurate on trees sprayed with coal-tar oil or DNOCHP-oils because the dead eggs were discolored. In the case of trees sprayed with water-gas tar oil there was not sufficient change in the appearance of the eggs to indicate correctly the toxicity of the material. The condition of eggs on check trees indicated that about 90 per cent were alive and that the average increase in infestation should have been about 28 times as great as the preceding year provided nothing prevented all the larvae from settling and developing on the bark. The number of young that actually settled and produced first-stage scale was only about eight times that of the number of old scale. Without theorizing on the cause of the discrepancy, the fact that such a difference in numbers of survivors existed and also because the chief interest of these studies lies in the actual reduction under field conditions, the proportion of young to old scale on treated and check plats has been used as the measure of the effects of the treatments.

Infested twigs and small branches were collected after all the eggs had hatched and the larvae had had sufficient time to settle and produce first-stage scale. The twigs were examined under a microscope in the laboratory and all the nonparasitized, overwintered scale in a certain area together with all the young insects in the same area were counted. Care was exercised to eliminate all scale two years of age or older since these did not contain viable eggs at the time of treatment. The examination proceeded from the leaves and new growth towards the base of each twig and small branch. This method was followed so that any newly hatched nymphs that might have crawled on the green tissue and settled there might not be missed. Except in a few instances where all the infestation was on a single branch, a number of small branches from each tree were used to secure the data. Having made counts varying—with one exception where the infestation was very light—from 100 to 800 nonparasitized old scale and of the accompanying young scale on each tree, depending on the number of treated trees available,[2] the number of old and young counted on each plat was summed except, of course, where only one tree in a plat was available. From these two numbers a ratio of the young to the old scale was computed by dividing the number of young scale by the number of old scale. To calculate the per cent efficiency of a treatment the following formula was used: $E = \frac{100(C-T)}{C} \cdots (1)$, in which C is the ratio of young to old on the check plat and T is the corresponding ratio for the treated plat. The same formula was used to compute the "percentage decrease of infestation" in table 3 by letting

[2] Some of the trees had been so severely injured by the oyster-shell scale and the winter of 1933-34 that only the tops were alive. In the case of a number of stronger trees the infestation was confined to the trunks and larger limbs. For these reasons the taking of data was impracticable on both classes of trees. There remained 56 trees from which counts were made. In several instances only a single tree was available for securing data on a certain treatment.

C represent the number of old scale and T represent the number of young scale on the same plat.

This raises the question of interpretation of efficiencies. Certainly no material would be worth considering that would allow an increase in the number of scale from year to year. A treatment that resulted in neither an increase nor a decrease—ratio 1—might be of value in light infestations, as it would prevent the scale from becoming a menace, or, in heavier infestations where it was desired to prevent a greater abundance of scale. From a practical aspect such a treatment would not be attractive to a grower unless other benefits were to be derived or the condition of the trees prevented the use of a more effective mixture. In the orchard in which the tests were made a ratio of 1 would have had an efficiency of 87.8 per cent. Table 2 shows the percentage efficiencies that would have been necessary to have caused certain specific reductions of oyster-shell scale in the experimental orchard during 1936. The percentage decrease of infestation seems to give a better picture of the effect of a treatment than does the percentage efficiency because it shows directly to what extent the number of insects has been reduced.

Table 2.—Percentage efficiencies necessary to give specific decrease in infestation. (Ratio of young to old in check plat = 8.2185.)

Per Cent Decrease in Infestation	Ratio Young to Old	Percentage Efficiency
0	1	87.8
25	.75	90.9
50	.50	93.9
75	.25	97
90	.10	98.8
95	.05	99.4
99	.01	99.9

A summary of the data secured with the several materials is shown in table 3. If decrease in infestation between 75 and 90 per cent is classed

Table 3.—Effects of treatments on the apple form of the oyster-shell scale.

Treatment	Per Cent Oil	Per Cent DNOCHP	No. Old Scale	No. Young Scale	Ratio Young to Old	Percentage Decrease of Infestation	Percentage Efficiency
Check			764	6279	8.2185		
Coal-tar oil	4.5		3360	343	.1021	89.8	98.8
Coal-tar oil	5.5		1200	200	.1667	83.3	98.
Coal-tar oil 4½%, lubricating oil 1%	5.5		1172	28	.0239	97.6	99.7
Extar 4½ gals. emulsion	2.4*		400	164	.41	59.	95.
Water-gas tar oil	4.5		800	758	.9475	5.3	88.5
Water-gas tar oil	5.5		712	695	.9761	2.4	88.1
Water-gas tar oil 4½%, lubricating oil 1%	5.5		800	210	.2625	73.8	96.8
DNOCHP-oil Brand A	3	.12	400	53	.1325	86.8	98.4
DNOCHP-oil Brand A	4	.16	800	80	.1	90.	98.8
DNOCHP-oil Brand A	6	.24	400	13	.0325	96.8	99.6
DNOCHP-oil Brand B	4	.20	400	10	.025	97.5	99.7
DNOCHP-oil Brand B	5	.25	400	18	.045	95.5	99.5
DNOCHP-oil Brand C	4	.17	800	33	.0413	95.9	99.5
DNOCHP-oil Brand C	5	.21	800	30	.0375	96.3	99.5

* The stock emulsion is claimed to contain 53 per cent of coal-tar oil and, in addition, other ingredients to control San José scale, so that perhaps the latter also had an effect on the oyster-shell scale.

as "good" and between 90 and 100 per cent as "excellent," all dilutions (except the 3 per cent concentration) of DNOCHP-oils and the combination of coal-tar oil with lubricating oil gave excellent control, while the 3 per cent concentration of DNOCHP-oil and the two concentrations of coal-tar oil gave good control. The two concentrations of water-gas tar oil gave very slight reduction in the number of scale. When mixed with lubricating oil, water-gas tar oil gave reasonably good reduction in infestation. It will be noted that the addition of lubricating oil to both coal-tar oil and water-gas tar oil markedly increased the value of these two materials. *Extar* produced only moderate reduction of the oyster-shell scale, but since the mixture also controlled San José scale it might have a use where these two insects are present on the same trees.

The effect of DNOCHP-oil on apple buds is similar to that of tar oil. For this reason the material must be applied before the silver-tip stage of the buds has been reached. Marked retardation in bud development occurred when the concentration exceeded 3 per cent. No injury to the buds occurred except in two instances where the emulsions "broke" in the tank. Also severe bud injury was observed with both coal-tar oil and DNOCHP-oil in an orchard sprayed to control rosy aphid and bud moth when the buds were in the late silver-tip stage. This experience indicates the necessity for treatment before the buds have reached the silver-tip stage if either of these two types of spray material are used.

Summary.—The experiments described above indicate that coal-tar oil emulsions when used at not less than 4.5 per cent of tar oil are of value in the control of the oyster-shell scale on apple and that the efficiency is increased by the addition of 1 per cent of lubricating oil. Also that lubricating oil in which has been dissolved about 4 per cent of dinitro-o-cyclohexylphenol will give excellent control of the insect if the oil content of the spray mixture is not less than 4 per cent. Water-gas tar oil cannot be regarded from these tests as being of much value for the control of oyster-shell scale on apple unless lubricating oil is added, and even then the results do not equal those secured with coal-tar oil or with lubricating oil containing dinitro-o-cyclohexylphenol.

Like tar oils, dinitro-o-cyclohexylphenol in oil must be applied before the silver-tip stage of the apple buds has been reached if injury to the latter is to be avoided. With all the mixtures practically no injury occurred to apple buds sprayed while dormant in the spring; that is, before the green-tip stage, provided the oils were well emulsified.—5-17-37.

Literature Cited

Hartzell, F. Z., S. W. Harman and T. W. Reed. 1935. Some recent developments in regard to tar distillate and tar lubricating oil sprays. Jour. Econ. Ent. **28**(2): 262–8. Apr.

The Colorado quarantine relating to the Colorado potato beetle which prohibited the entry of tomato and pepper plants into that part of the state west of the continental divide was modified March 15, 1937, to provide that the restriction would not apply to shipments from California and Nevada.

The tomato pinworm is the subject of quarantines recently placed by Colorado, Montana, Oregon and Washington. The quarantines differ as to states to which the restrictions apply and the conditions of certification. Such a quarantine is also in effect in Utah.

Orchard Experiments with Natural Cryolite for Codling Moth Control

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During the season of 1936, two orchards situated at New Paltz, N. Y., in the Hudson valley, were used for spraying experiments to test natural cryolite. The effectiveness of control of the codling moth was used as the criterion at the end of the season.

To give natural cryolite as severe a test as possible in the Hudson valley region, an old abandoned orchard which had not been sprayed for the last 15 years was used for one of the experiments. Early in spring, 10 trees which looked as if they might bear fruit were marked in this orchard. These were sprayed with a combination of natural cryolite (4 lbs. to 100 gallons of water), wettable sulfur or *Kolofog* (6 lbs. to 100 gallons), and the sticker known as *Goulac* (1 lb. to 100 gallons). Six sprays in all were used, the first being applied on May 2 and the last on June 30. At the end of the season only two trees, which were Rhode

Table 1.—Codling moth injuries in abandoned orchard on Rhode Island Greening apples sprayed with natural cryolite, and unsprayed checks.

TREATMENT	NO. APPLES	CODLING MOTH INJURIES				
		No. Stings	No. Entries	Per Cent Stings	Per Cent Entries	Per Cent Totals
Natural cryolite	1355	60	193	4.43	14.22	18.7
Unsprayed checks	400	203	172	50.7	43	93.7

Island Greenings, bore enough fruit to count. Three unsprayed trees of the same variety were found in this orchard and the fruit on them was counted and examined for comparison. Data were obtained with regard to codling moth stings and entries, green worm injuries, curculio work and apple scab, but only the figures on codling moth injuries will be reported in this paper.

As shown in table 1, codling moth stings on sprayed fruit averaged 4.43 per cent while on unsprayed fruit they averaged 50.7 per cent; the entries on sprayed fruit averaged 14.22 per cent and on unsprayed fruit they averaged 43 per cent. It was then computed that the total codling moth injury on unsprayed fruit in this abandoned orchard was between 85 and 90 per cent, whereas the total injury on the sprayed fruit was 18.7 per cent.

Since these apples were not picked until October 5, second-brood codling moth had also contributed to the damage. If another spray had been applied, the figure 18.7 per cent would undoubtedly have been lowered. During the spraying season, however, the weather was so hot and dry that few if any of the orchardists in this region used more than six sprays for fear of excess residue. It was observed that no spray injury was obtained with natural cryolite when spraying was done at temperatures of 100° F or more. Lime in any form was not used since it is entirely incompatible with cryolite or other fluorine insecticides. The fact that several workers have obtained poor control with natural cryolite is no doubt due

to their use of lime sulfur or Bordeaux with it. The marked reduction in this orchard of codling moth injury from 90 to 18.7 per cent indicates that natural cryolite is an effective insecticide for codling moth control.

Adjoining this old orchard is a well-kept commercial orchard in which 10 trees were chosen for another type of experiment. This group of trees received four sprays of lead arsenate plus lime sulfur at the beginning of the season, and two of natural cryolite plus *Kolofog* applied on June 9 and 30. The peak of egg hatching of the codling moth was about June 12. The last two sprays of natural cryolite were directed particularly against the codling moth. This spray schedule was also designed to reduce the lead and arsenic residues.

Near this group of 10 trees there were two trees which were left unsprayed to serve as checks. The remainder of the trees in this orchard received five lead arsenate sprays and one final calcium arsenate spray.

Table 2 presents the data for this experiment.

There were three varieties of apples in this group of 10 trees. The data show that there is an appreciable variation in susceptibility to codling moth injury in the different varieties. Of the three varieties represented in the group, the least susceptible was the McIntosh, followed by Baldwin and then by Rhode Island Greening. Apples of these same varieties which had received the lead and calcium arsenate spray schedule were compared with those which had received the lead arsenate–natural cryolite spray schedule. The data show that natural cryolite gave better protection against the codling moth in the case of McIntosh and Baldwin, and but slightly poorer in the case of Rhode Island Greening. The two unsprayed check trees, which were Baldwins, showed that the average codling moth injuries in this commercial orchard was about 20.8 per cent as against the 85 to 90 per cent in the abandoned orchard adjoining it.

Table 2.—Codling moth control with five lead arsenate and one calcium arsenate sprays as against four lead arsenate and two natural cryolite sprays.

Spray Material	Codling Moth Infestation Per Cent Stings	Per Cent Entries	Per Cent Totals
McIntosh			
5 lead arsenate, 1 calcium arsenate	3.07	.16	3.23
4 lead arsenate, 2 natural cryolite	1.36	.66	2.03
Baldwin			
5 lead arsenate, 1 calcium arsenate	10.67	1.7	12.33
4 lead arsenate, 2 natural cryolite	4.6	2	6.6
Unsprayed checks	10.6	10.14	20.8
Rhode Island Greening			
5 lead arsenate, 1 calcium arsenate	5.3	2.4	7.7
4 lead arsenate, 2 natural cryolite	4.17	5.62	9.8

Table 3.—Grains per pound of fruit of arsenic trioxide and fluorine residues.

Spray Material	As_2O_3 Residue	F_2 Residue
Winter Banana		
4 lead arsenate, 2 natural cryolite	.001	.01
Rhode Island Greening		
5 lead arsenate, 1 calcium arsenate	.001	
6 natural cryolite		.05

In order to see what influence residue might have had on these results, analyses were made for arsenic trioxide and fluorine residues. Greenings which had received six sprays of natural cryolite had a fluorine residue of .05 grain per pound of fruit. Evidently the sticker *Goulac* was very efficient. Extensive washing experiments conducted on

the Pacific coast have shown that the addition of 1 to 2 per cent boric acid to the 1 to 2 per cent hydrochloric acid will help to reduce the fluorine residue to below the tolerance limit.

Table 3 gives the residue figures for several samples of apples. Of special interest is the sample of Winter Bananas which had received four lead arsenate and two natural cryolite sprays. They were found to have .001 grain of arsenic trioxide and .01 grain of fluorine. Since both the arsenic trioxide and the fluorine residues are below the tolerance limit, it would seem that a spray schedule consisting of four lead arsenate sprays and two natural cryolite sprays would be the solution to the residue problem as well as that of codling moth control.—4-6-37.

Tests with Summer-oil Emulsions on Peach

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Experiments were conducted during the summer of 1936 to determine the limits of safety of sulfur–oil combinations on peach. The work differed from that of the preceding year (Frost 1936) in that the types of oils rather than the types of sulfurs were varied. On May 20 a few trees were sprayed at the experiment station. Other tests were made in a commercial peach orchard in Adams county, Pa. The following materials

Table 1.—Defoliation counts on peach trees sprayed May 20.

Material	No. Leaves Examined	No. Terminals Examined	Per Cent Defoliation
1½% *NOPCO Soluble Fish Oil, Dritomic Sulfur*	500	34	18.6*
1½% *NOPCO Soluble Fish Oil, Dritomic Sulfur*	500	47	14.4*
1½% *NOPCO Soluble Fish Oil, Dritomic Sulfur*, basic lead arsenate	500	45	9
1½% *NOPCO Soluble Fish Oil, Dritomic Sulfur*, basic lead arsenate	500	41	8.6
1½% *Citrus Spra Cream*	500	35	7.4
1½% *Dormant Spra Cream*	500	33	5

* Vitality of these trees very low.

were used: *Spread–Ol* 31 per cent, Silmo Chemical Co. Inc.; *NOPCO Soluble Fish Oil* 25 per cent, National Oil Products Co.; *Medol* 80 per cent, Balfour Gutherie & Co.; *Orthol–K* 83 per cent, California Spray Chemical Corp.; *Citrus Spray Cream* 83 to 85 per cent, and *Dormant Spra Cream* 83 per cent, B. G. Pratt Co.; *Linseed Potash Soap* 50 per cent soap, Crystal Soap and Chemical Co. Eight commercial sulfurs were used. Their analyses are given in table 4. Both the dry and wet forms of *Flotation Sulfur* were used, the wet form containing 10 to 12

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Fig. 1.—Injury to peach trees by sulfur–oil sprays. *A*, Heaviest injury, due to sulfur–oil combination, as twig appeared on September 15. The spray was applied June 18; leaves unfolding later were not affected by later sprays. *B*, Typical tree in a sulfur–oil emulsion block as it appeared on September 15. *C*, Branch of the tree above, showing injury caused by sulfur–oil spray applied on June 18.

per cent iron oxide. In conducting the tests the materials were used at the same concentrations; namely one-half, 1 and 1½ per cent. These are indicated in tables 1, 2 and 6.

Spray injury to peach foliage is a more serious problem when applications are made early in the summer. Table 1 shows the results of sprays applied on May 20. Trees sprayed on June 18, table 2, show on the whole, less injury than those sprayed on May 20. The results indicated in this table were obtained from sprays applied on June 18 and July 30. Although figures are not available, no injury resulted from applications

made on July 30. It should be remembered that all peach trees in Adams county were considerably weakened by extreme weather which occurred during the previous winter. Consequently the spray injury tests were very severe. Since summer-oil emulsions would normally be applied for red spider during July or August, the injury mentioned in tables 1 and 2 would never occur. A true index of foliage injury cannot be obtained from table 2 because leaves showing one or more small burned areas were counted as injured leaves. Even where the injury was most serious, the leaves averaged less than four or five holes or burned areas, fig. 1, *A*.

Table 2.—Analysis of spray injury in the Lott orchard, 1936.*

Plot	Treatment	Inches Average Growth	Per Cent Defoliation	Per Cent Foliage Injury	Inches Average Growth	Per Cent Defoliation	Per Cent Foliage Injury
		South Haven			*Hale*		
1	1½% Soluble fish-oil soap, *Silmo Spread-Ol, Dritomic Sulfur*	12.1	2	63.5	11.3	8	59.5
2	1½% Soluble fish-oil soap, *NOPCO Soluble Fish Oil, Dritomic Sulfur*	10.7	3.7	46.5	10.7	6	41
3	1½% *Medol, Dritomic Sulfur*	11.3	4.7	31.5	10.7	6.8	22
4	1½% *Orthol-K, Dritomic Sulfur*	16.8			11.2	7.1	33.3
5	1½% *Citrus Spra Cream, Dritomic Sulfur*	10.3	3.3	36.5	11.3	8.2	36
6	1½% Potassium-linseed-oil soap, *Dritomic Sul ur*				11.9	8.8	25
7	Self-boiled lime sulfur	9.7	7	26	11	4	11.5
		Belle of Georgia			*Elberta*		
1	1½% Soluble fish-oil soap, *Silmo Spread-Ol, Dritomic Sulfur*	6.7	7.5	71.5	13.4	8.4	59.5
2	1½% Soluble fish-oil soap, *NOPCO Soluble Fish Oil, Dritomic Sulfur*	6.2	6.2	49.5	12.1	6	52
3	1½% *Medol, Dritomic Sulfur*	6.8	6.4	28.7	11.7	5.3	37
4	1½% *Orthol-K, Dritomic Sulfur*	5.6	6	34	16.9	8	29
5	1½% *Citrus Spra Cream, Dritomic Sulfur*	6.8	6.7	33.5	12.9	7.8	37
6	1½% Potassium-linseed-oil, soap, *Dritomic Sulfur*				12.9	5	32.5
7	Self-boiled lime sulfur	7.1	7.9	4.5	13.8	8.6	8

* Growth and defoliation are figured on the basis of 100 terminals, foliage injury on the basis of 200 leaves.

Some trouble was experienced in applying the sulfur–oil combinations. Soluble fish-oil soap at the heavy concentrations foamed excessively and the pump sucked air as the material in the tank lowered. The *Dritomic Sulfur*–oil combination tended to clog the screen of the sprayer, at times cutting down the pressure. The figures in table 3 show that *Dritomic Sulfur* makes the poorest combination with oil emulsions. In orchard work, the difficulty was overcome by removing the screen. These difficulties led to the laboratory tests summarized in table 3. The spray materials summarized in table 2 were applied in a commercial orchard using a *Friend* power sprayer and 500 pounds pressure. The first application was made on June 18, the second on July 30. Soap and oils were used at 1½ per cent concentrations. *Dritomic Sulfur*, especially adapted for peach, was added at the rate of 5 pounds to 100 gallons. By error, plot 4 received a double application of sulfur. On July 28 it was sprayed with self-boiled lime sulfur and followed with the sulfur–oil combination on July 30. Sulfur was dropped from the applications to plots 5 and 6 on July 30 because these also received self-boiled lime sulfur on July 28.

Table 3.—Sulfur residue on 40-mesh screen of wettable sulfurs used at the rate of 5 pounds dry weight to 100 gallons. Soaps used at one-half per cent concentrations, oil emulsions at 1½ per cent concentrations.

Mixture with Sulfur	Weight of Sulfur, Grams		
	Suspension	Sediment	Total
	No Oil or Soap		
Dritomic	.0	1.2	1.2
Koloform	T	1.5	1.5
Kolofog	.0	0	0
Mulsoid	.0	.3	.3
Sulcoloid	.0	.3	.3
Wet *Flotation Sulfur*	.0	2.6	2.6
Magnetic	.0	.1	.1
	NOPCO Soluble Fish Oil		
Flowers of sulfur	.0	0	0
	Potassium–Linseed-oil Soap		
Flowers of sulfur	.0	0	0
	Medol		
Dritomic	.3	8.8	9.1
Koloform	.3	2.8	3.1
Kolofog	.0	0	0
Mulsoid	.0	.3	.3
Sulcoloid	T	1	1
Wet *Flotation Sulfur*	.0	2.7	2.7
Dry *Flotation Sulfur*	.0	.6	.6
Magnetic	.0	.2	.2
Flowers of sulfur	.7	19.8	20.5
Self-boiled lime sulfur	T	1.9	1.9
	Orthol-K		
Dritomic	.1	11.9	12
Koloform	.2	5.2	5.4
Kolofog	.0	0	0
Mulsoid	.0	.7	.7
Sulcoloid	T	14.4	14.4
Wet *Flotation Sulfur*	T	3.5	3.5
Dry *Flotation Sulfur*	.0	.7	.7
Magnetic	T	1.6	1.6
Flowers of sulfur	T	18.6	18.6
Self-boiled lime sulfur	T	1.1	1.1
	Citrus Spra Cream		
Dritomic	T	2.2	2.2
Koloform	.3	2.5	2.8
Kolofog	.0	0	0
Mulsoid	.0	.2	.2
Sulcoloid	.3	2.2	2.5
Wet *Flotation Sulfur*	.0	2.4	2.4
Dry *Flotation Sulfur*	.0	.5	.5
Magnetic	.0	.1	.1
Flowers of sulfur	T	5.5	5.5
Self-boiled lime sulfur	.2	1.2	1.4

Compatibility of sulfurs with soaps and oil emulsions.—Some forms of sulfur mix with oil emulsions better than others. This was determined by mixing various wettable sulfurs with different oil emulsions and

pouring them through a 40-mesh screen. All wettable sulfurs are, of course, ground fine enough to pass through such a screen. but their combination with oil emulsions often forms mixtures that clog screens of even larger mesh. One gallon of each of the combinations mentioned in table 3 was thoroughly mixed with a wooden paddle. The upper two-thirds was siphoned off and the material collecting on the screen constituted the suspended sulfur. The balance of the mixture was then poured through the screen and what remained constituted the sediment. The

Table 4.—Residue on 40-mesh screen of mixture of sulfur with *Citrus Spra Cream*. Wettable sulfurs were used on the basis of 5 pounds of actual sulfur to 100 gallons of water.

Sulfur	Per Cent Sulfur	Pounds per 100 Gallons Water	Weight of Sulfur, Grams		
			Suspension	Sediment	Total
Dritomic	90	5.5	.4	1.9	2.3
Koloform	54	9.5	.7	2.8	3.5
Kolofog	30	16.5	0	0	0
Mulsoid	95	5.5	0	0	0
Sulcoloid	95	5.5	.6	1.8	2.4
Flotation, dry	80	6.5	0	0	0
Flotation, wet	41.8*	11.5	0	4.5	4.5
Magnetic	98.5	.5	0	0	0
Self-boiled lime sulfur	50.	10	0	.5	.5

* Per cent sulfur and 10 to 12 per cent iron oxide.

sulfur thus caught upon the screen was washed onto filter paper, dried and weighed and the results used as an index of the compatibility of the sulfurs and oil emulsions. The soaps were used at one-half per cent concentrations and the oil emulsions at 1½ per cent concentrations. In table 3, the wettable sulfurs were used at the rate of 5 pounds to 100 gallons. In table 4, the wettable sulfurs were figured on the basis of 5 pounds of actual sulfur to 100 gallons.

All forms of sulfur mix well with soaps. This is true of potassium–linseed-oil soap as well as soluble fish-oil soap. No sediment was found either in orchard work or laboratory tests when the mixture was reasonably agitated. Bentonite–sulfur mixed perfectly with all types of oil emulsions. *Mulsoid Sulfur*, *Magnetic Sulfur* and dry *Flotation Sulfur* also mixed well with the oils. The remaining sulfurs mixed too poorly to assure a good spraying job without the removal of the screen from the spray machine. The wetting agent had much to do with the way in

Table 5.—Cost of 1 per cent soap and summer-oil emulsions.

Material	Per Cent Active Ingredients	Dilution per 100 Gallons Water	Cost per Gallon	Cost per 100 Gallons*
Summer-oil emulsion	83	1.2	$.35	$ .42
Soluble fish-oil soap	25	4	.35	1.40
Potassium–linseed-oil soap	50	2	.80	1.60

* Diluted spray.

which the sulfur and the oil emulsion combined. Sulfurs with a high percentage of hydrated lime usually made poor combinations and these mixtures settled rapidly. A slight difference was noted in the mixing quality of the different emulsions, the sulfurs mixing better with *Citrus Spra Cream*.

Terrapin scale, *Lecanium nigrofasciatum*.—Tests were conducted with oil emulsions and soaps against the peach lecanium. The sprays were directed against the larvae on the underside of the leaves and the partially mature scales on the new wood. At the time of the applications many male pupae were present. These are more difficult to kill than the

Table 6.—Laboratory tests against immature peach lecanium.

Treatment	Leaf Counts		Twig Counts	
	No. Scales	Per Cent Kill	No. Scales	Per Cent Kill
	Test No. 1—Light Spraying			
1% *NOPCO Soluble Fish Oil*	1058	95	80	87.5
½% *NOPCO Soluble Fish Oil*	1220	90.9	121	73.5
1% Potassium–linseed-oil soap	797	92.7	58	72.4
½% Poassium–linseed-oil soap	732	82.2	58	80.8
1% *Medol*				
½% *Medol*				
Check	508	7.1	92	6.5
	Test No. 2—Heavy Spraying			
1% *NOPCO Soluble Fish Oil*	112	100	180	93.3
½% *NOPCO Soluble Fish Oil*	102	89.2	231	91.2
1% Potassium–linseed-oil soap	125	100	82	96.4
½% Potassium–linseed-oil soap	95	94.7	111	78.4
1% *Medol*	101	96	225	99.5
½% *Medol*	109	94.4	159	83
Check	101	11.8	77	10.3

larvae. On June 29 a light application was made. On August 20 a more thorough application was made. On the whole, a 1 per cent soap or oil emulsion seemed sufficient to give a satisfactory kill of these scales. The results suggest additional value to a contact spray applied during the summer when red spider is the major problem, table 6.

Conclusions.—Slight injury resulted from the applications of sulfur–oil combinations to peach during 1936. This was due partly to the extremely weaked condition of the trees, also to early dates of application. Although the per cent of injury indicated in the tables seems high, the actual injury to the trees was almost negligible. By selecting a suitable type of sulfur, the injury can be reduced.

One per cent actual soap by volume seems sufficient to kill the summer broods of peach lecanium. One half per cent is not sufficient.—7-10-37.

Literature Cited

Frost, S. W. 1936. Soap washes and oil emulsions as summer sprays for peach. Jour. Econ. Ent. 29(2):364–9. Apr.

The California quarantine relating to the sweetpotato weevil was revised May 11 to add five Mississippi counties and one Georgia county to the infested area, and to clarify provisions as to the entry of morning glory plants.

CURRENT CONTRIBUTIONS

Effect of Growth of Pea Weevil on Weight and Germination of Seed Peas

T. A. Brindley and F. G. Hinman, *U. S. Department of Agriculture, Bureau of Entomology and Plant Quarantine*

In the literature relating to the pea weevil, *Bruchus pisorum* L., appear many apparently conflicting statements concerning the effect of the damage done by feeding of the larvae of this insect upon the germination of seed peas, *Pisum sativum*. The statements range from that of

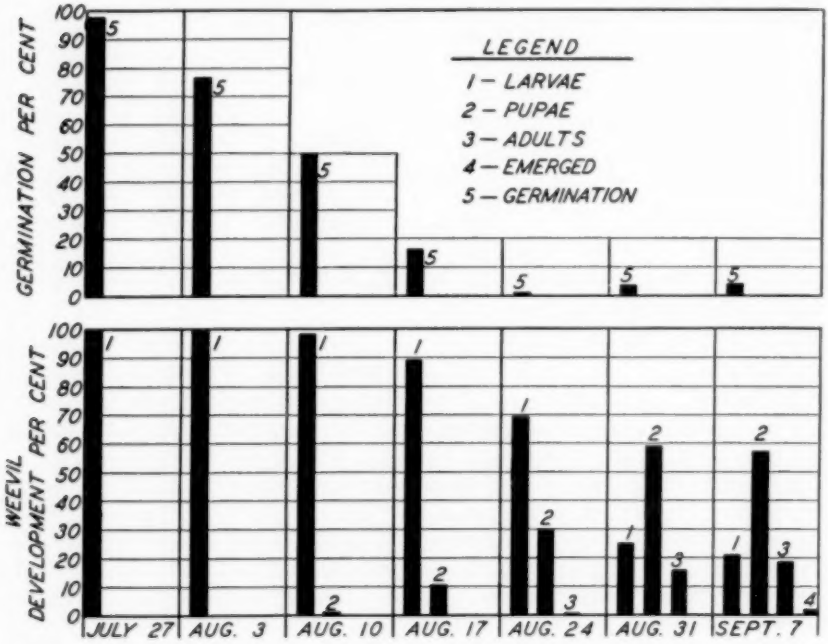

Fig. 1.—Influence of weevil development on germination of Alaska seed peas, Moscow, Idaho, 1933.

Swan *et al.* (1882) who wrote, "though peas that have been inhabited by the weevil will frequently germinate, they rarely make strong and productive plants," to that of Washburn (1890), who says "infested peas are nearly, if not quite as sure to grow as those not touched." In a field test of 23 varieties, each represented by 100 seeds, Popenoe, Mason & Marlatt (1890) reported that 10 varieties failed to produce any sprouts and only 3.8 per cent of the other 13 produced plants of average size and strength. Weed (1891), on the other hand, found that about five-sixths of the weevil-infested seeds germinated but made a poorer stand of vines than did sound peas. Fletcher (1903) reported that about 12 per cent of

the infested seeds of small varieties and 18 per cent of the infested seeds of larger varieties produced plants which developed but were less vigorous than normal plants. Skaife (1918), in South Africa, planted 200 peas from which the weevils had emerged and found that 12 seeds germinated but the vines did not produce a crop. He discovered that even seeds with undamaged germ did not germinate because rot soon destroyed them. Hulburt & Whitney (1934) found that 6.5 per cent of weevil-infested Alaska seeds produced strong sprouts.

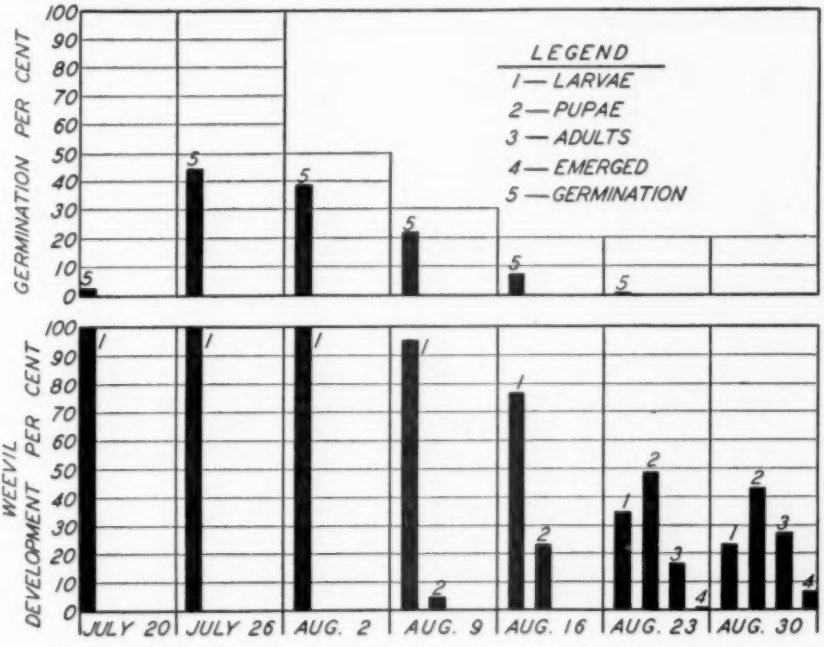

Fig. 2.—Influence of weevil development on germination of Alaska seed peas, Moscow, Idaho, 1934.

An explanation of this variation in results was sought through a series of germination and weight studies, which were carried out in connection with a study of the biology of the pea weevil.

Korab (1927) found that the loss in weight of different varieties of peas infested with the pea weevil ranged from 9.6 to 30.3 per cent. No other statement concerning the weight of such peas has been found in literature.

Experimental procedure.—During 1933, 1934 and 1935, at the same time that records were made of the development of the pea weevil, samples of infested peas were picked and fumigated at regular intervals from the time they began to ripen until emergence of the adult weevils was well under way. The small lots involved were fumigated with carbon disulfide in a small container. Neither the dosage, the fumigation time nor the temperature was held constant, since death of the insects was

the only object. From each of these samples 200 weevil-infested seeds and 200 sound seeds were chosen for germination tests. All these tests were made during the winter following the fall in which the peas were gathered, by the federal seed laboratory at the Oregon Agricultural College, Corvallis.

Weight studies were conducted on 100 per cent weevil-infested peas and, as a check, on equal quantities of 100 per cent sound, or field-run, fumigated peas. The peas were harvested just as soon as they were ripe enough to thresh. Only seeds that were retained on a seed screen with sixteen-sixty-fourth-inch circular openings were used in the weighing

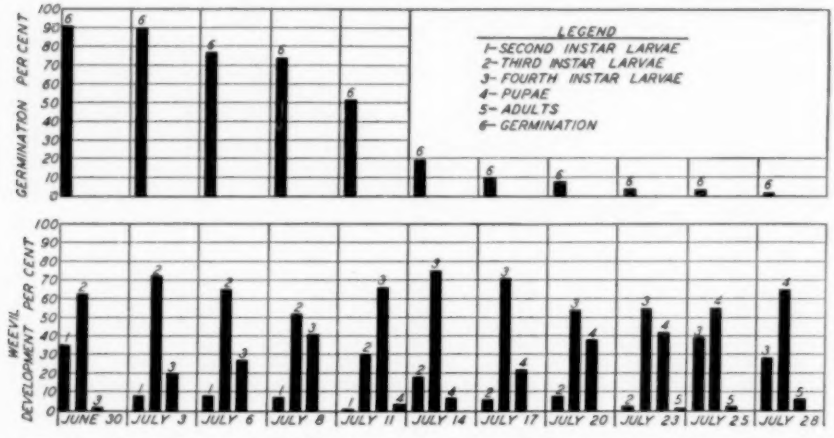

Fig. 3.—Influence of weevil development on germination of Austrian winter field peas, Corvallis, Ore., 1934.

tests. The weights of the samples were taken at 2-day intervals until the weight loss remained constant.

All weight and germination tests were carried out on a wilt-resistant strain of Alaska seed peas at Moscow, Idaho, and on Austrian winter field peas at Corvallis, Ore.

Results.—The results of the germination tests conducted during 1933 and 1934 indicated, as illustrated in figs. 1, 2, 3 and 4, that the percentage of germination of 100 per cent weevil-infested peas depends upon the extent to which the pea weevil has developed when the peas are picked and fumigated. It will be noted that 98 per cent of the weevil-infested Alaska peas picked on July 27, 1933, germinated and that the percentage of germination decreased rapidly after that date. In 1934 only a very few of the peas picked on July 20 sprouted, but 45 per cent germinated from those picked on July 26, and the percentage of germination then decreased with each successive picking. The low germination in the sample picked on July 20 was undoubtedly due to the fact that the viability of the seeds was reduced by fumigation with carbon disulfide before they had ripened completely, for only 68.5 per cent of the sound peas sprouted, whereas in 17 other tests of sound peas from the same patch, picked at later dates, the germination averaged 93.8

per cent. In connection with early fumigation care should always be taken that no seed peas are fumigated until the peas are thoroughly dry, for the viability of the seeds may be destroyed if the material to be treated is not dry.

Figure 3 shows the same correlation between weevil development and viability of the seeds in the case of Austrian winter field peas. Of the first peas picked on June 30, 1934, 91 per cent of those that were infested produced strong sprouts. The percentage germinating decreased gradually until on July 28 only 1.5 per cent of the weevil-infested material produced strong sprouts. The first field of Austrian winter peas was

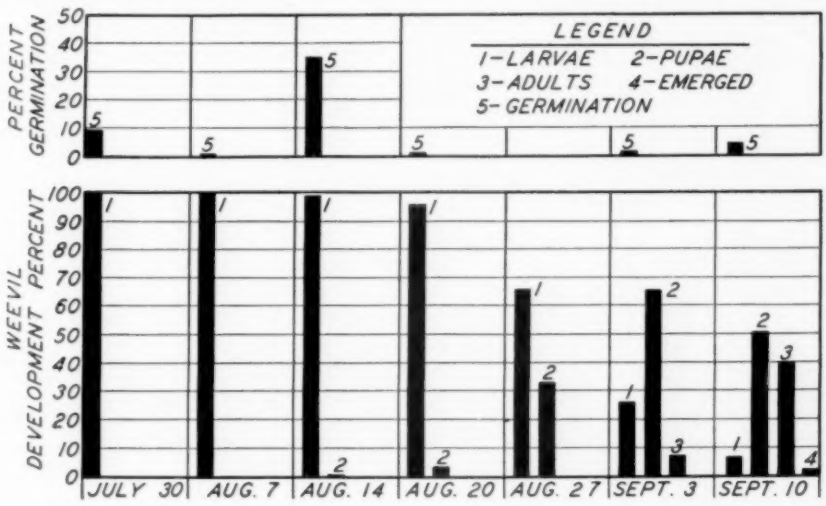

Fig. 4.—Influence of weevil development on germination of Alaska seed peas, Moscow, Idaho, 1935.

harvested on the date that the first sample was fumigated for a germination test.

The developmental records show that the greater part of the damage to the pea is accomplished by the larva in the last instar.

In 1935 there was no apparent correlation between germination and weevil development, fig. 4. All the germination tests were low, with the exception of the sample picked on August 14, which germinated 35 per cent. Sound seeds from the same lot picked on July 30 gave a germination test of 87.5 per cent, and 97.5 per cent of those picked on September 10 were viable after fumigation.

The reason for the variation from the results expected in 1935 is not known, but the peas tested were so heavily infested that several larvae had attempted to enter most of the seeds. This may have reduced the viability in the first samples fumigated.

Weight loss also is correlated closely with weevil development, as illustrated in figs. 5 and 6. In 1933 a sample of sound peas with an initial weight of 2319 grams on July 26 lost 27 grams in 42 days, while a sample

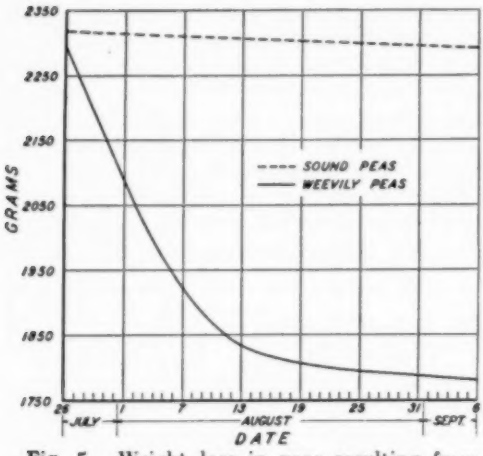

Fig. 5.—Weight loss in peas resulting from feeding by pea weevil, Moscow, Idaho, 1933.

of 100 per cent weevil-infested peas, hand-picked from the same patch, with an initial weight of 2295 grams, lost 515 grams, fig. 5. This was a loss of 22.4 per cent in the infested peas and only 1.1 per cent in the sound peas.

The same type of study was conducted in 1935 on a series of consecutive weekly plantings. For this experiment 1000 grams of weevil-infested peas were selected by hand and the same quantity of field-run peas was fumigated as checks. The maximum loss in weight in the unfumigated infested material was 16.4 per cent, while in the fumigated checks the maximum loss was 4.4 per cent, fig. 6. The minimum loss in weight was 14.4 per cent in the infested material, while in the checks it was 2.2 per cent.

Discussion.—A study of the material presented above indicates that the germination of weevil-infested peas is correlated with the stage of development of the pea weevil at the time of fumigation. During some seasons, at least, it is possible for a large percentage of 100 per cent weevil-infested peas to produce strong sprouts if the peas are threshed and fumigated as soon as they ripen. In sections devoted to the production of seed peas exclusively, and among plant breeders and seedmen interested in saving as many seeds of newly developed varieties as possible, early fumigation should materially decrease the loss in germination due to the development of the pea weevil.

In sections devoted to the growing of seed peas, where the removal of infested material is not necessary, as in the production of Austrian winter field peas, early fumigation will result in a material saving in weight. In these sections it is conceivable that early fumigation may prevent loss due to lowered germiation to such an extent that even heavily infested material may be acceptable commercially. In practice it is frequently difficult for the farmer to carry out these operations as soon as he desires, and the delay of only a day or two in harvesting and fumigating may lower the germination of his crop sufficiently to make it unacceptable until some of the weevily material has been cleaned out.

Summary.—The loss in weight and viability of weevil-infested peas is correlated with the development of the pea weevil and therefore increases rapidly with each successive day until the larvae within them have finished feeding.

During some seasons 100 per cent weevil-infested peas, when fumi-

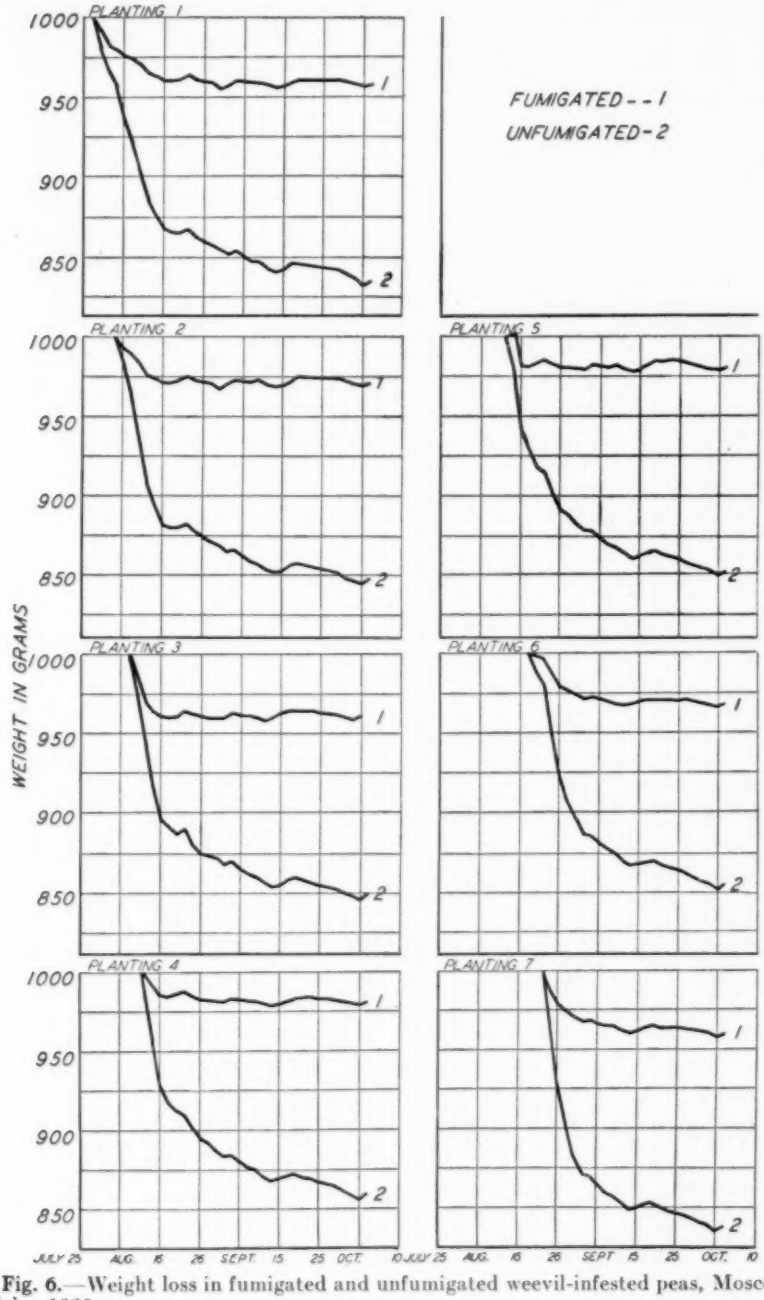

Fig. 6.—Weight loss in fumigated and unfumigated weevil-infested peas, Moscow, Idaho, 1935.

gated as soon as they ripen, will germinate nearly as well as sound peas.

Weight loss in 100 per cent weevil-infested Alaska peas may be as high as 22.4 per cent, in comparison with 1.1 per cent weight loss in sound peas.—4-26-37.

Literature Cited

Fletcher, James. 1903. Can the pea weevil be exterminated? U.S.D.A. Div. Ent. Bul. **40**:69–74.

Hulburt, H. W. and G. M. Whitney. 1934. Effect of seed injury on the germination of *Pisum sativum*. Jour. Am. Soc. Agron. **26**:876–84.

Korab, I. I. 1927. The pea and the pea weevil. Belaya-Cerkov Plant-Breeding Station Bul. **2**(Ser. 4):81–126. Illus. (Translated from the Russian. Translation in library of B.E.P.Q., U.S.D.A.)

Popenoe, E. A., S. C. Mason and F. A. Marlatt. 1809. The germination of weeviled peas. Kans. Ag. Exp. Sta. Bul. **19**:193–6.

Skaife, S. H. 1918. Pea and bean weevils. Union So. Africa Dept. Ag. Bul. **12**. 32 pp., illus.

Swan, R. T., N. M. Curtis, *et al.* 1882. N. Y. State Exp. Sta. Rept. **1**:141–2.

Washburn, F. L. 1890. Entomology. Ore. Ag. Exp. Sta. Bul. **5**:1–23. Illus.

Weed, H. E. 1891. Injurious insects. Miss. Ag. Exp. Sta. Bul. **14**:13–14. Illus.

Blapstinus substriatus Champion,[1] a Sporadic Wheat Pest in Montana

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In late May of 1931 farmers and county agents first sent in to the Department of Entomology at the Montana experiment station samples of wheat plants which had been cut or chewed and with them the beetles which they claimed were responsible for the damage.

The beetle was identified by Dr. E. A. Chapin, of the Taxonomic Division at Washington, D. C., as *Blapstinus gregalis* Casey, a small tenebrionid. Subsequent specimens sent to Washington were identified as *B. substriatus* Champion. As there appeared to be considerable confusion regarding the correct identification, two series of about 200 beetles from two widely separated localities were sent to Dr. Chapin, after examination of which he reported:

> On the basis of this material, Casey's table to the species (Coleopt. Notices II, pp. 419–423, 1890) and the material in the Casey Collection, the two species *Blapstinus substriatus* Champion and *B. gregalis* Casey appear to be the same. The name *Blapstinus substriatus* Champ. should be used in preference to the later name *B. gregalis* Csy.

No reference can be found in the economic literature regarding this beetle as a crop pest, although several other species of the same genus of darkling beetles are so recorded. *Blapstinus brevicollis* Lec. is reported as a pest of sugar beets, horseradish, grapes and dried fruits in California (Howard 1908), *B. metallicus* has been recorded as a pest of young tobacco plants (Hooker 1907), *B. coronadensis* and *B. dilatatus* destroying young bell peppers in California (Campbell 1922), and *B. pimalis* Csy. as a cotton pest in Arizona (Campbell 1924).

[1] Family Tenebrionidae.

[2] Contribution from Montana State College, Agricultural Experiment Station Paper 80, journal series.

Blapstinus substriatus is widely distributed over Montana, collection records in the spring of 1931 being indicated in fig. 1.

Records of injury include damage to spring and winter wheat, beets, flax and cultivated mustard, as well as several garden crops. The worst damage has been reported from Teton and Cascade counties although it is strongly suspected that many fields in other sections have been attacked but not reported. Inquiries elicited the information that extensive crop damage in certain areas some 10 years previously had been asso-

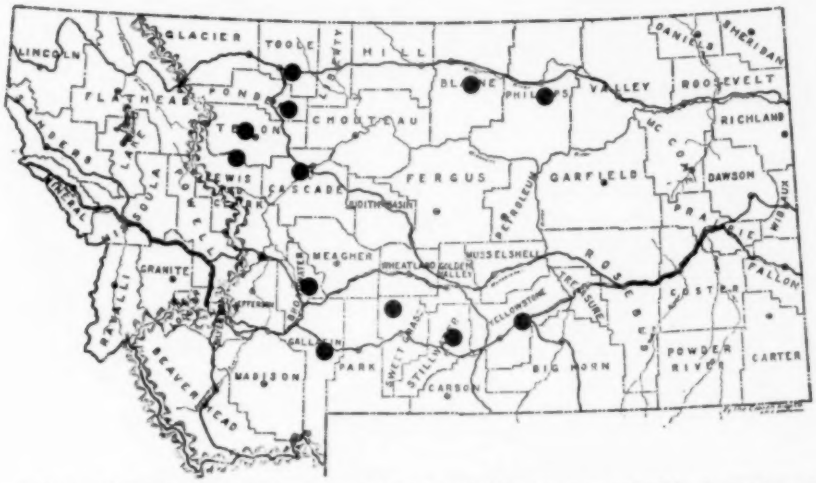

Fig. 1.—Distribution of *Blapstinus substriatus* in Montana as noted in the spring of 1931.

ciated with an abundance of these black beetles although the affected farmers did not at that time correlate these two facts and the experiment station was not informed.

1931 field records of damage.—In Pondera county beets were heavily attacked with approximately 25 per cent injury while in Teton county several fields of winter wheat were almost destroyed, many of them having to be reseeded to spring wheat. This reseeded crop at the time of first inspection, May 22, was also being severely damaged. At this time the spring wheat was up about 3 inches and beetles were numerous all over the field. By actual count, there were at least 25 beetles to the square foot, and under single clods of earth and larger stones as many as 100 to 150 were observed. A 50 per cent damage to flax was reported. In Cascade county spring wheat was severely damaged.

Nature of the injury.—Some of the spring wheat examined appeared to show typical pale western cutworm damage, the shoots being nipped off an inch beneath the soil surface and the withered plant showing up conspicuously. The beetles can dig into dry friable soil quite readily. Many plants were nibbled at the soil surface and appeared sickly. The beetles also climbed the shoots and while almost every plant had two or three beetles attacking the whole length of the leaf, many blades of the

young plants had 10 or a dozen beetles nibbling away at them, the leaves showing frayed and serrated edges. The individual beetle does not do a great deal of damage but by reason of their great numbers they can ruin a field in a comparatively short time.

Many blades of wheat were found on the ground, and some appeared to be sticking out of the loose soil. Investigation brought to light a somewhat unusual habit possessed by this beetle. Shoots were nipped off and the blades of wheat would be dragged down into the soil and there eaten. As many as eight beetles were observed chewing up a single blade of wheat which had been dragged an inch below the surface.

Several of the sickly plants showed a small puncture about a quarter of an inch above the kernel, which was apparently the result of the beetle chewing on it. In the particular field of spring wheat where these observations were made, about one plant in three had been destroyed. The beetles were as destructive in crops on summer fallow as in stubbled-in crops. The usual farming practice in the most heavily infested counties is to summer-fallow following wheat.

General observations.—*Blapstinus substriatus* appears to find in dry or drought conditions an ideal environment for its optimum development. Up to the last week in May when the beetles were first studied in the field, there had been no spring rains in Teton county and the ground was dry and dusty on the surface although fields summer fallowed during the previous year had adequate moisture. The beetles were at this time at their maximum numbers. By June 26 the beetles were relatively few in the grain fields and the wheat had stooled out and was making vigorous growth. About July 12 heavy rains occurred, and when four days later the fields were visited numerous dead beetles were found under stones and clods, in some cases 10 beetles being found under one stone. Live beetles had practically disappeared from the fields at this time and the wheat was well headed out. There was still, however, a sprinkling of beetles in the weedy edges of the fields. Most of the beetles had by this time deposited their eggs and those left appeared to prefer the soft-leaved weeds to the mature wheat leaves. The hot dry weather which followed the rain stimulated the surviving beetles into great activity. They were observed running rapidly over the ground or perched on some weed and nibbling the leaves. The weed *Malvastrum coccineum* appeared to be a favored food plant, but other roadside weeds such as tumble mustard, *Sysimbrium altissimum* L., wiregrass, *Stipa comata*, and Russian thistle, *Salsola pestifer*, were also eaten. *Blapstinus substriatus* is a general feeder and can thrive on several and widely different host plants.

A few *Blapstinus substraitus* adults had been noticed all summer on the local golf course. On August 17 a mature larva of *Blapstinus* species was observed crawling rapidly over the baked ground between grass clumps. This observation led to the conclusion that the fields at Dutton where adults had been so plentiful earlier in the season should afford good collecting of larvae. Two days later, August 19, this district was visited. Surprisingly few larvae could be found, however, but a new generation of adults was present in great abundance. Under every Russian thistle plant in the weedy summer fallow were hundreds of *Blapstinus*—

533 and 410 by actual count in two cases. The few larvae recovered were dug up in the first 4 inches of soil, and some even under stones on the dusty surface. Many adults, including several freshly emerged individuals were uncovered in the first 4 inches, the newly emerged beetles usually in the surface 2 inches. These adults, both newly emerged and fully pigmented individuals, were all very active. The majority of this new generation of beetles was buried beneath the large Russian thistle plants where the temperature was comparatively cool, 24.8° C in the heat of the day. The exposed soil surface temperature at this time read 45.5° C.

On August 26, a visit was paid to a semi-arid rolling plains country about 45 miles from Bozeman and known locally as Nigger Hollow. Here the beetles were found in numbers along the roadside, chiefly in the plant debris underneath rabbit brush, *Chrysothamnus* sp., and sagebrush, *Artemesia* sp. They were especially numerous under dried cattle and horse droppings. The dried horse droppings appeared to be a favored place, its loose texture permitting the beetles to burrow through to the center. Under an old wooden fence post lying on the ground, 500 beetles were recovered. On September 3 the Nigger Hollow area was again visited. *Blapstinus* were not so plentiful but numbers were found at Russian thistle, apparently sucking the sap from the base of the stem at ground level.

On October 16, the last visit of the year was made to Dutton. Beetles were less numerous than on the previous visit but inspection of the Russian thistle plants showed them to be present and active when disturbed. The adult beetle often "played dead" when first disturbed but after remaining quiescent for some minutes would crawl rapidly away.

On May 11, 1932, the Dutton district was revisited. The weedy and heavily infested summer fallow field of the previous year was in spring wheat and no *Blapstinus* beetles were in evidence, either in the soil or under clods or stones. Good moisture was observed at a depth of half an inch. The only beetles seen were observed in the drier, weedy edges of the fields, and they were relatively scarce. There had been good spring rains previously and added accumulation of moisture from the winter snows.

On May 23 Nigger Hollow was revisited. *Blapstinus* adults were found beneath the sagebrush and rabbit brush where they had apparently hibernated. The beetles were still bunched up, 25 to 30 in about 3 cubic inches of loose material 2 to 3 inches below the surface.

On June 15, it was found in Nigger Hollow that recent but localized showers had resulted in a good condition of soil moisture in some areas; in these areas a four-hour search of the debris beneath the plants produced only 20 beetles. In the drier sections where rain had not fallen, each rabbit brush plant produced 20 to 50 beetles. Again it was decidedly noticeable that dry situations appeared to be the favored habitat.

Laboratory studies.—On June 10, 1931, in Teton county a farmer and his two boys collected more than 9000 beetles in six hours. These were shipped into the laboratory at Bozeman and isolated on June 19 in 3-ounce cans. The sexes were not distinguishable and dissection of some 50 individuals showed no developing eggs in the ovaries of the females.

In some of the cans damp, sifted soil was placed, in others dry soil, and in a third batch, merely blotting paper which was moistened slightly. The beetles were fed foliage of potato, alfalfa, kale, corn, Wandering Jew (*Tradescantia*), beets, wheat, barley, oats and honey syrup.

Eggs were first observed in the cans on July 19, and within a few days numerous larvae appeared. The high mortality rate among the beetles and our inability to distinguish the sexes precluded the obtaining of information as to the number of eggs laid by the individual beetle.

Beetles from the Nigger Hollow area, collected and isolated on June 15, commenced to oviposit on June 23. All of these oviposition cages were kept at room temperature. With the exception of the batch fed on honey, more eggs were produced and the beetles lived longer in the dry soil environment than in the others. Also the mortality under damp conditions was high—75 per cent in two weeks, while during that same period there was no mortality in the dry soil. In damp soil with honey as food, the beetles lived 33 days and with dry soil and honey only 19 days. No eggs were produced on the honey diet. Beetles fed on the other foods produced eggs.

The egg of *B. substriatus* is a typical coleopterous egg, bluntly ovoid and slightly pitted on the surface. When newly laid it is transluscent white but quickly becomes opaque as the embryo develops. The average size of the newly laid egg is .475 by .76 mm.

Egg laying continued to the end of July. The eggs hatched in three to six days and larval development at room temperature was rapid, the average for 80 individuals from hatching to pupation being 41.8 days. The larvae were fed on rootlets of the various adult foods. Unlike the beetles, the early instar larvae require moist soil to develop; those kept in dry soil die soon after hatching. No information is available on the relative sizes of the larvae in the different instars except that the average size of the first instar is 1.96 mm. and of the second 2.87 mm. Only two molts were observed, the first at seven days and the second at 20 days. After the second molt, growth was rapid, and measurements indicated at least three additional molts. The mature larva just before pupation measures 10 mm. The average duration of the pupal stage at room temperature was eight days, the period from egg to adult 50 days.

Effects of varied temperatures.—Constant exposure of the beetles at 45° C proved fatal in two days. First-instar larvae at this temperature survived five days. At a constant temperature of 35° C on dry soil the beetles thrived and laid numerous eggs which hatched within three days but on damp soil the beetles died in a short time without ovipositing. At a constant temperature of 25° C on dry soil, the beetles fed well and laid several eggs which hatched in eight days. At 15° C on dry soil the beetles fed occasionally and lived for six weeks but produced no eggs. At 8° C the beetles did not feed but in five weeks there was no mortality.

Effect of winter conditions on adults.—Several hundred adults collected in the field in late fall were placed in cages sunk into the ground with 6 inches of the debris which forms their normal hibernation quarters at Nigger Hollow. In the spring after the snows had disappeared the cages were dug up and examined. The debris was damp and no living beetles were recovered. The temperatures to which the beetles had been

exposed were not in excess of −3° C. which is well above the temperature this insect must experience in nature.

Control measures.—Essig (1929) writing of some unnamed *Blapstinus* observed that standard poisoned bran mixtures were effective against them. He further recommended wrapping the stems of young transplanted tomato plants with tissue paper for control against *Blapstinus* under garden conditions. Campbell (1924) recommended *Kaolin* or tobacco dust spread around young plants as an effective control.

Blapstinus substriatus was successfully controlled by the standard bran mash formula. The beetles readily ate the mixture in the laboratory, the result of several experiments showing 80–100 per cent mortality in 36 hours. Field trials were made in a badly infested field of spring wheat. One plant in three showed beetle damage or had been destroyed. On a random square yard 102 living beetles were counted and 97 on another. Four quarter-acre plots were treated as follows: (1) bran and white arsenic bait only; (2) bran and white arsenic with amyl acetate; (3) standard grasshopper bait—bran, white arsenic, salt, molasses, amyl acetate; (4) same as No. 3 but without amyl acetate.

The plots were treated between 5 and 7 o'clock in the evening. The weather was cool and windy, threatening rain. Observations as long as light lasted showed a few beetles eating bran.

A light shower fell during the night. After 15 hours only very few dead beetles were observed. After 40 hours, no beetles were feeding on the wheat and there was approximately 40 per cent mortality with many beetles obviously feeling the effects of poison. After 60 hours, there was 80 per cent mortality. No difference could be observed in the kill with the different baits, the bran–arsenic alone being eaten as readily as the other baits.

Conclusion.—*Blapstinus substriatus* is normally present every year in small numbers over a wide area of the state of Montana. Dry weather conditions with an absence of precipitation in the spring would appear to insure optimum conditions for an increase of this beetle to outbreak proportions. Following the heavy spring rains of 1932, no further trouble was experienced from this pest in areas severely attacked during the previous year. The wide distribution of this beetle and its general feeding habits render it therefore a potential source of trouble should climatic conditions at any time favor its increase. Under field conditions standard poisoned bran mixtures were effective in controlling this pest.—6-24-37.

Literature Cited

Campbell, R. E. 1922. Injury to bell peppers by *Blapstinus coronadensis* Blaisd. and *B. dilatatus*. Jour. Econ. Ent. **15**(2):363. Apr.

Campbell, R. E. 1924. Notes on injurious southwestern Tenebrionidae (Col.) Ent. News **35**:1–7.

deOng, E. R. 1918. Insect pests of the castor bean. Jour. Econ. Ent. **11**(3):480. June.

Essig, E. O. 1929. Insects of Western North America, p. 432. Macmillan Co., N. Y.

Hooker, W. A. 1907. Proceedings of the nineteenth annual meeting of the Assoc. of Econ. Ent. U.S.D.A. Bur. of Ent. Bul. **67**:110.

Howard, L. O. 1908. The principal injurious insects of the year 1908. Yearbook of the U.S.D.A., p. 571.

Scientific Notes

Possible Migration of Diamondback Moth.—Diamondback moth, *Plutella maculipennis* (Curt.), was very numerous over the northeast quarter of Colorado for a number of days during the early and middle parts of May 1937. The large numbers could not be accounted for from the infestation occurring in this region in 1936.

Definite counts made in 1936 in connection with test of nonarsenical insecticides showed the larvae of this species to be below normal in numbers on cabbage and cauliflower, with a decreasing population as fall approached. For instance, the average diamondback larval population per plant for 50 cabbage plants in each count was as follows: July 27, 2.3; July 31, 1.46; Aug. 14, .35; Aug. 19, .133 and Sept. 11, .033 larvae. Outbreaks on wild hosts were not noted and could hardly have existed without a heavier infestation on cabbage and cauliflower.

The first moths of this spring's heavy infestation were noted by the writer during the late afternoon of April 27. During that afternoon there had been a westerly wind of about 9 miles per hour that carried considerable dust. At about 5 p.m. I left the office and drove a few blocks, where I left the car for about 30 minutes. During this time the wind changed to the northeast and increased to 14 miles per hour. This wind carried a heavy load of dust which enveloped the region until about 8:30 p.m., when a rain cleared the sky. Upon my return to the car probably not more than five to eight minutes after the appearance of the stronger wind, I counted 22 diamondback moths on the leeward side of the small coupe. Examinations of shrubbery and lawns that evening and the next day showed the moths to be numerous and they have continued so to date, bringing many inquiries as to their identity and possible menace.

At the time of writing adults and larva are very numerous on all cultivated and wild cruciferous plants.

On May 23, in a one-half acre planting of cabbage and cauliflower, drilled in rows 14 inches apart for the production of plants, it was estimated that there were 10 moths and 20 to 40 larvae to each linear foot of row. The plants were about 3 inches tall.

As near as can be determined by the U. S. Weather Bureau officials the dust carried by the storm of April 27 originated in extreme southeastern Colorado and the northern portion of New Mexico.

GEORGE M. LIST, *Colorado Agricultural Experiment Station, Fort Collins.*—5-28-37.

Aseptic Rearing of Bark Beetles.—It has long been observed that both living and dead pines, after attack by certain *Dendroctonus* and *Ips* bark beetles, almost invariably become infected by blue-staining fungi or yeasts, or both. The regularity of the association raises the question whether the insects can develop without their fungous association.

This possibility was investigated by Grossmann (1930) who reared larvae and adults of *Ips typographus* from the eggs, which she attempted to surface sterilize. She started with 120 eggs, from which seven adults developed, but only one was free from yeasts. She does not make clear whether this one adult was free from all microorganisms, or only from yeasts. Her conclusion was that the fungi are not essential for the development of the insects, but that a kind of commensal relation exists between them.

During the summers of 1934 and 1936, freshly attacked pine, both standing and felled, containing eggs of *Dendroctonus frontalis* Zimm., *Ips grandicollis* Eich and *I. calligraphus* Germ. was available at the Bent Creek laboratory of the Appalachian Forest Experiment Station at Asheville, N. C. This material was used in rearing adult beetles from the eggs under aseptic conditions by the method here described.

An egg was removed from the exposed gallery with a needle, freed from frass, and placed on the surface of a sterile, malt-agar slant, where it was washed for 10 to 20 seconds with a small camel's-hair brush wet with 95 per cent ethanol, and left to develop at room temperature. The aseptically hatched larvae so obtained were then transferred to sterile incubators, held at room temperature in the laboratory desk.

An incubator consisted of an approximately square piece of phloem in which a niche had been cut just large enough to hold the young larva. This square of phloem was placed between two pieces of plate or heavy window glass. The individual incubators were wrapped in paper and autoclaved for 30 minutes at 15 pounds pressure before the larvae were placed in the niche. Two precautions had to be observed in preparing such an incubator: first, the phloem had to be high in moisture; second, the larva had to be narrowly confined. If the

chamber was too large, or the glass not tightly fitted, the larva could not get the proper "purchase" to chew an entrance into the phloem.

The larva was transferred to the niche with a sterile needle or brush, the upper glass pressed down firmly on the phloem, and the two glass edges sealed with adhesive tape, which was then heavily coated with paraffin. This sealing was designed to keep the humidity within the critical limits for the incubation period of approximately five weeks. During this time observations were made at intervals on the condition and vigor of the larva. Incidentally, very interesting observations on feeding habits, exuviation and pupation can be made during this time with a binocular microscope.

When an adult developed, it, the frass, phloem, and pupal and larval skins when possible, were bacteriologically cultured and the sterility could be proved. Under these conditions of asepsis, one larva of *Dendroctonus frontalis* out of an original eight reached the adult stage, two out of six larvae of *Ips calligraphus*, and 10 out of 71 larvae of *I. grandicollis* were reared to maturity. Most of the failures appeared to be due to drying of the phloem, several were due to the larvae escaping from the block, two adults of *I. grandicollis* developed in blocks but became moldy and could not be counted as aseptic, while a few died for reasons that could not be ascertained. All beetles were active and within the limits of size (Blackman 1922) recorded for these species. The small number of adults, together with the varying dates of emergence, made it impossible to test the beetles for fecundity.

These experiments offer no explanation for the beetle–yeast–fungus association, since the writer found evidence that neither the yeasts nor blue-staining fungi so generally found in association with *Dendroctonus frontalis*, *Ips calligraphus* or *I. grandicollis* are essential for the development of the adult beetle from the egg.

Literature Cited

Blackman, M. W. 1922. Mississippi bark beetles. Miss. Ag. Exp. Sta. Tech. Bul. **11.** 130 pp., illus.

Grosman, H. 1930. Beitrage zur Kenntniss der Lebensgemeinschaft Zwischen Borkenkäfern und Pilzen. Ztschr. Parasitenk **3**: 56–102. Illus.

Eugene C. Holst, *U. S. Bureau of Plant Industry, Morristown, N. J.*—4-22-37.

***Diabroticia connexa* Lec. Transported in Vegetables.**—A live active specimen of this chrysomelid was found in the kitchen of our Haddon Heights, N. J., residence by my wife on February 23, 1937. *D. connexa*, a close relative of the 12-spotted cucumber beetle, is known apparently only from Mexico and southern Texas. The individual on hand undoubtedly arrived at one of the Philadelphia markets in a carload of produce from the winter vegetable growing area of southern Texas, was transported to a local vegetable market and delivered to our house with a basket of groceries, only to be pinned, labeled and placed in the writer's collection.

L. J. Bottimer, *Insecticide Testing Laboratory, Beltsville, Md.*—5-29-37.

New Pest of Sugar Cane in Continental United States.—An infestation of the West Indian sugar cane mite, *Tarsonemus bancrofti* Michael, was found at Houma, La., on October 7, 1935. This was the first discovery of this pest in sugar cane fields in continental United States. The canes infested consisted of experimental plantings of sorghum–sugar cane hybrids and adjoining sugar cane plants growing in an area approximately 20 by 30 feet. An attempt to eradicate this infestation was apparently successful. A report on methods and results of this eradication attempt will be made at a later date.

Tarsonemus bancrofti was found in a 9-acre field of commercial sugar cane and in experimental plantings adjoining at Canal Point, Fla., on January 23, 1936. In September 1936 an infestation was found on a few stalks of cane in experimental plantings at Belle Glade, Fla. An attempt has been made to eradicate this pest from the experimental plantings at these two locations.

Although careful inspections were made at all places, no mites were found in experimental plantings of sugar cane at Poplarville or Meridian, Miss., Cairo, Ga., nor at Clewiston, Pahokee, Quincy or Gainesville, Fla. Examinations were made in many commercial fields in these states without finding additional infested areas.

Tarsonemus bancrofti has been reported from the West Indies, Brazil, Peru, the Philippines and Australia. This mite is very small and colorless to pale white in the nymphal

stage. The young nymphs are most often found between the leaf sheath and the stalk of sugar cane. The older stages are found embedded in the rind, on the cane bud, and on the leaf sheaths. When embedded they form blisterlike, more or less round protuberances on the surface which are light amber and darken to reddish brown with age. These roundish pustules have craterlike depressions in their centers. The presence of the mite is best recognized by these blisterlike areas, which are characteristic of this species.

Reports from other countries on injury caused by *Tarsonemus bancrofti* have varied. By some it is considered as of little importance whereas others state that it occasions heavy losses. Damage apparently varies widely with local conditions and with varieties. It was apparent from the examinations made of the American infestations that there would be some direct loss from mite injury, and an indirect loss from red rot and other disease organisms entering mite lesions on the stalks and leaf sheaths. Although the mite appears to be a minor pest on most of the commercial varieties now grown in the United States, the amount of injury on these varieties makes it desirable to restrict its spread or eradicate it where practicable.

J. W. INGRAM, *U. S. Department of Agriculture, Bureau of Entomology and Plant Quarantine.* —6-1-37.

Lime Sulfur to Control Forest Tent Caterpillar.—For several years prune growers in the Umpqua Valley in Oregon have reported noticeable reduction or total absence of the forest tent caterpillar, *Malacosoma disstria* Hbn., in orchards where lime sulfur was used at dormant strength. Further observations were made during the current season in the Milton-Freewater district in Oregon by Assistant County Agent H. F. Cline, Umatilla county, and O. T. McWhorter, Extension Horticulturist for Oregon State College, which substantiate previous reports from the Umpqua Valley.

During the current season several plots were sprayed experimentally for the control of pear thrips, *Taenothrips inconsequens* Uzel, in the Umpqua Valley. Some of these plots received one to three applications of lime sulfur 3 gallons, nicotine sulfate 1 pint to 100 gallons of water. It was interesting to observe that the lime sulfur-sprayed plots had few or no caterpillars while adjacent unsprayed plots were severely infested. Numbers of applications did not appear to increase the mortality of the caterpillars since one application gave excellent control. Plots sprayed with 2 per cent oil emulsion and nicotine did not control the caterpillars. The eggs apparently hatch on lime sulfur-sprayed trees but the caterpillars do not develop and soon die.

S. C. JONES, *Oregon State College, Corvallis.*—6-14-37.

Myiasis of Baby in Utah.—A case of cutaneous myiasis of a baby, due to maggots of what appeared to be *Wohlfahrtia meigenii* Shiner, came under the observation of the senior author during June of 1935. The baby, a male, was born in a hospital at Ogden, Utah, May 23, 1935, being a few weeks premature. Mother and child were in good condition when discharged from the hospital June 1. On June 7 the mother noticed a small rash around the left ear and back of the neck of the infant. This became more definite, the child being quite irritable on June 9. Next day the child was brought to the office, and small pustules were found around the left ear, on the head, neck, back, leg and finger. A red induration was present around the larger pustules. Recovery was rapid and complete following removal of the 24 larvae, although some of the lesions drained pus for a few days. Cases of cutaneous myiasis in man have not been common in Utah.

CLARK L. RICH, M.D., *Ogden, Utah,* and GEORGE F. KNOWLTON, *Utah Agricultural Experiment Station, Logan.*—4-23-37.

Recovery of Larvae Paralyzed by *Microbracon hebetor* Say.—*Microbracon hebetor* is an abundant parasite of larvae of the raisin moth, *Ephestia figulilella* Gregson, and of the Indian-meal moth, *Plodia interpunctella* Hübner, in California. During the winter of 1935–36 life history studies of the species, with full-grown raisin moth larvae as hosts, were conducted at controlled temperatures fluctuating slightly around 80 and 90° F. In these studies the wasps, either as mated pairs or as isolated unfertilized females, were provided at 24-hour intervals with a larger number of active larvae than they were able to paralyze. The paralyzed larvae were removed daily, and those stung each day by each female were held in a separate container.

Under these conditions, in which the females had access to an overabundance of host material throughout their lives, recovery of paralyzed larvae occurred frequently. Revival generally required several days. Female parasites frequently emerged in the containers and re-paralyzed larvae that were slowly convalescing. Of 837 paralyzed hosts held at 90° F, 117, or 14 per cent, recovered; at 80° F the figure was 17.5 per cent of 589 larvae. Records of cultures held at 80° F showed that revival averaged 11.9 per cent of the larvae paralyzed during the first 15 days of the female's life, 28.5 per cent of those paralyzed during the next 15 days, and 29.3 per cent of those paralyzed during the third 15 days. Metamorphosis of the recovered raisin moth larvae was normal.

HEBER C. DONOHOE, *U. S. Department of Agriculture, Bureau of Entomology and Plant Quarantine.*—5-24-37.

Chemical and Insecticidal Tests of Samples of *Tephrosia toxicaria*.—Tests made some time ago (Sept. 1934) on samples of *Tephrosia* (*Cracca*) *toxicaria* examined by the Bureau of Entomology and Plant Quarantine are of interest in connection with the composition and insecticidal value of this genus of plants. This species occurs in South and Central America. Its insecticidal properties have been studied by Tattersfield & Gimingham (1927) and others, and may be attributed to compounds of the rotenone group, since

Table 1.—Tests of acetone extracts of *Tephrosia toxicaria* against houseflies.

Sample No.	Part of Plant	Per Cent Total Acetone Extractives	Modified Durham Color Test, Approximate Per Cent*	Percentage Mortality of Houseflies with Dosage Indicated†		
				16 mg.	8 mg.	4 mg.
1	Roots	5.1	1.	90	30	
2	Roots	4.1	.5	30	10	
3	Roots	4.9	.5	38	9	
4	Roots	4.5	.5	44	12	
5	Seeds	14.4	2.		88	30

* Rotenone plus deguelin.
† 1 cc. equivalent to indicated weight of plant material.

deguelin and toxicarol have been isolated from it (Clark 1930, 1931). Of the five samples tested, four were obtained from Venezuela and the other from El Salvador.

Acetone extracts of these samples were prepared, subjected to the modified Durham color test for rotenone plus deguelin, and tested against houseflies by methods previously described for domestic species of *Tephrosia* (Jones, Campbell & Sullivan 1935a). The results are shown in table 1.

Results for tests for rotenone against houseflies, made within a few days of the previous tests, are as shown in the tabulation which follows.

Mg. per Cc.	Per Cent Mortality
.25	74
.125	44
.0625	14

The results by the modified Durham color test indicate approximately the amount of material giving a blue color equivalent to that of rotenone (roughly the amount of rotenone plus deguelin). Stem material obtained with sample 3 gave a faintly positive color test. Sample 5, the material from El Salvador, was accompanied by smaller samples of stems and roots. Of these the stems gave a faintly positive color reaction while the roots gave only a trace of blue color. With samples 2, 3 and 4 the first color reaction on the addition of ammonium hydroxide was an evanescent orange, which was then followed by a blue green. Ordinarily, as in samples 1 and 5, the blue or blue-green color immediately follows the addition of the ammonium hydroxide.

A small amount of crystalline material (a few tenths of 1 per cent) was separated from sample 1 and was shown to be rotenone by a melting-point determination and microscopic examination. This sample was identified as *Tephrosia toxicaria* by the Bureau of Plant Industry. The isolation of rotenone from *Tephrosia toxicaria* has not hitherto been reported. A very small amount of crystalline material was also isolated from sample 2 and, although it gave a positive Durham color reaction, other tests indicated that it was not rotenone. The amount at hand was not sufficient for any further work to be done with this material.

From the mortality results it is possible to calculate an approximate value for "rotenone

based on toxicity" to houseflies by the method described for other rotenone-bearing plants (Jones, Campbell & Sullivan 1935b). The values so obtained are, for sample 5 about 3 per cent, for sample 1 about 1.5 per cent, and for samples 2, 3 and 4 about .5 per cent or less Because of the small number of tests made and the narrow range of concentrations used, these values are not exact. As with domestic species of *Tephrosia*, however, the toxicity tests agree approximately with the results of the modified Durham color test.

Literature Cited

Clark, E. P. 1930. Jour. Am. Chem. Soc. **52**: 2461.
Clark, E. P. 1931. Jour. Am. Chem. Soc. **53**: 313.
Jones, H. A., F. L. Campbell and W. N. Sullivan. 1935a. Soap **11**(9): 99.
Jones, H. A., F. L. Campbell and W. N. Sullivan. 1935b. Jour. Econ. Ent. **28**(2): 285–92. Apr.
Tattersfield, F. and C. T. Gimingham. 1927. Jour. Soc. Chem. Ind. **46**: 368T–72T.

Howard A. Jones and W. N. Sullivan, *U. S. Department of Agriculture, Bureau of Entomology and Plant Quarantine, Beltsville, Md.*—5-20-37.

Indian-meal Moth in California.—Entomological literature contains little positive information on the occurrence of the Indian-meal moth, *Plodia interpunctella* Hbn., in drying and dried fruits and in waste fruits in the field, but data on its occurrence in the Central Valley of California under such conditions have been accumulated during the last several years. Donohoe & Barnes (1934) note its occurrence in malt-sirup bait traps in vineyards and fig orchards and state that they have found larvae attacking figs on the ground in the field.

Many records of slight infestation of figs in the field have been obtained, but in all cases the infestation by the Indian-meal moth has been subordinate to that of the raisin moth, *Ephestia figulilella* Gregson. For example, from many samples of first-crop figs collected from the ground in the summers of 1932 and 1933, 3001 raisin moth larvae and 31 Indian-meal moth larvae were recorded. However, in the case of figs held in temporary storage on ranches in the fall the Indian-meal moth larvae become numerous, and observations have been made of severe infestations in figs in farmyards and ranch storages in the spring following the year in which the fruit was dried, and subsequent thereto.

The Indian-meal moth has also been recorded in the field on drying and dried raisins, waste fruits and fruit refuse, including mulberries, cherries, apricot pits and peach pits. It readily attacks other varieties after they have been dried and placed in storage, but its presence in nature on waste fruits and fruit refuse of these varieties has not been recorded. The more important of these include pruces, peaches, apricots and nectarines, and these frequently suffer severe damage under storage conditions. The insect has been collected also from samples of dates taken from the ground beneath the palms in the Coachella Valley.

Of interest is the infestation encountered in the vineyards in raisins in stacked wooden drying trays. Prior to 1934, the Indian-meal moth was rarely found in samples of raisins collected from trays in the vineyards, although full-grown larvae appeared in the fall in small numbers about raisin storages as they were migrating from raisins recently received from ranches. In the fall of 1934, 7.6 per cent of 79 samples of Thompson Seedless (Sultanina), Muscat and Sultana raisins from wooden trays were slightly infested. In 1935, 35.4 per cent of 73 samples of the same varieties were infested. In this case, however, the infestation in individual lots ranged from slight to severe, a maximum infestation of 24,800 larvae per ton being indicated on September 23, from a composite sample from 10 trays of Sultana in a vineyard. In 1935, Thompson Seedless raisin samples were 42 per cent infested, Sultana 41 per cent, and Muscat not at all. The species has been found in only one field sample of Muscat and has never been found in Zante currants (raisins of Corinth).

In 1934 and 1935 samples of Thompson Seedless, Sultana and Zante currant raisins in biscuit-rolled paper trays contained no infestation. In the latter year four lots of samples of Thompson Seedless raisins from the same type of paper tray and parallel samples from adjacent wooden trays were obtained. Examination of samples from three of these lots indicated an average of 3770 Indian-meal moth stages per ton while the fourth was uninfested.

Extensive work during the winters of 1931 to 1934 inclusive, during which possible

hibernation quarters, such as soil, leaves, loose outer bark of grapevines and miscellaneous locations, were investigated, has never revealed the species overwintering in the field except in unprotected boxes of apricot pits, where many larvae were found in February 1931. In open-sided raisin storage sheds the Indian-meal moth overwinters as small to full-grown larvae in the fruit. Full-grown larvae also hibernate in cracks in storage boxes and beneath foundation timbers and other objects close to the surface of the soil. On several occasions they have been noted beneath stones and pieces of asphalt partially buried in the soil about stacks in dry locations. None has been found in soil away from the foundation timbers and similar protecting structures, and none in areas wet by winter rains.

LITERATURE CITED

Donohoe, Heber C. and D. F. Barnes. 1934. Notes on field trapping of Lepidoptera attacking dried fruits. JOUR. ECON. ENT. 27(5): 1067–72. Oct.

HEBER C. DONOHOE, *U. S. Department of Agriculture, Bureau of Entomology and Plant Quarantine.*—4-20-37.

Parasitism of Codling Moth Larvae of Native Parasites at Cornelia, Ga., in 1936.[1]—A combination of several species of native larval parasites form a very important factor in controlling codling moth in North Georgia. The percentage of parasitism for 1936 varied somewhat for several collections but was found to run nearly twice as high in an unsprayed and uncultivated orchard as in a sprayed and cultivated orchard. Parasitism was also considerably higher in the first brood than in the second.

First-brood parasitism was 40.8 per cent in the unsprayed orchard, and 21.7 per cent in the sprayed orchard. Second-brood parasitism was 22.2 per cent in the unsprayed and 12.8 per cent in the sprayed orchard. The average for both broods was 33.4 per cent in the unsprayed and 17.2 per cent in the sprayed orchard. The average parasitism in both sprayed and unsprayed orchards was 31.5 per cent for the first brood and 19.5 per cent for the second brood. The average for all larvae under observation during the season was 25.4 per cent.

Ascogaster carpocapsae (Vier.) was by far the most important parasite involved, 21.3 per cent of the larvae being parasitized by this species. *Pristomerus agalis* (Cress.) parasitized 2.7 per cent and *Phanerotoma tibialis* (Hold.) 1.4 per cent. From 37 per cent of the larvae considered as parasitized by *A. carpocapsae*, *Perilampus* species were reared, the latter being hyperparasites of *Ascogaster*.

J. E. WEBB, JR., *Georgia State Department of Entomology, Cornelia.*—4-16-37.

[1] Parasite identifications through the courtesy of A. B. Gahan, C. F. W. Muesebeck, and R. A. Cushman of the Smithsonian Institution, U. S. National Museum, Washington, D. C.

Relative Effectiveness of Homologs of Paris Green Against Confused Flour Beetle—Dobroscky (1935) used the confused flour beetle, *Tribolium confusum* Duval, as a test insect for comparing the effectiveness of lead arsenate and natural cryolite. The beetles were placed in mixtures of the insecticide and flour. The per cent mortality after a given period of exposure depended on the proportion of insecticide in the mixture. J. L. Horsfall, of the American Cyanamid Co., independently suggested this method to the writers as a possible convenient means of rapidly detecting toxicity of finely powdered substances. The writers applied it to the testing of homologs of Paris green, which were prepared and provided by F. E. Dearborn, Division of Insecticide Investigations, Bureau of Entomology and Plant Quarantine. The composition of the greens listed in table 1 and the text may be found in papers by Dearborn (1935, 1936, 1937a, 1937b). The writers are also indebted to H. H. Shepard, University of Minnesota, for helpful suggestions on the rearing of *Tribolium*.

Preliminary experiments were made to find suitable concentrations and periods of exposure for comparison of the effectiveness of the greens against lead arsenate. Finally the following conditions were adopted: Concentration of insecticide 10 per cent (.2 gm. insecticide mixed with 1.8 gm. finely milled whole-wheat flour in 20 by 80 mm. shell vials), about 20 young beetles per vial, period of exposure 24 hours, temperature about 27° C, relative humidity of cabinet about 50 per cent. The results given in table 1 were obtained under the conditions just described. They comprise four series of tests, lead arsenate being

used as a standard of comparison in each series. There was no mortality of beetles in the untreated checks. Although incomplete, the results are published at this time because the senior author had to drop the work for other duties and because little is now known about the effectiveness of Dearborn's greens.

The results show distinct differences in effectiveness among the greens and demonstrate that all are more effective than lead arsenate under the conditions of these experiments. The results also show that Dobroscky's method is suitable for laboratory tests of certain powdered insecticides.

Table 1.—Relative effectiveness of homologs of Paris green against the confused flour beetle.

Materials	No. Tests	Total No. Beetles	Per Cent Mortality		
			Min.	Mean	Max.
Copper stearoarsenite	8	164	65	88	100
Soybean oil green	8	174	63	84	100
Linseed oil green	12	268	63	83	100
Fish oil green	8	160	29	56	76
Copper oleoarsenite	8	164	17	27	35
Lead arsenate	11	231	0	7	15

Duplicate tests under the foregoing conditions were made with other greens with the following mean per cent mortalities, which are not strictly comparable with those in table 1: Copper crotonoarsenite 98, copper lauroarsenite 92, peanut oil green 91, copper monochloracetoarsenite 64, copper dichloracetoarsenite 62, copper acetoarsenite (Paris green) 51, lead arsenate 11.

The higher members of this homologous series seem in general to be more effective than the lower members. This may be due to differences in physical properties, the higher members adhering more readily to the beetles and perhaps affecting them partly by contact action. For example, in a duplicate test beetles were dusted with linseed oil green and transferred to clean flour; at the end of 24 hours, 35 per cent were dead. Differences in particle size among the greens may also have played a part in the differences in effectiveness observed. It should be possible to find practical applications for the higher greens, which have both toxicity and inherent adhesive properties.

Literature Cited

Dearborn, F. E. 1935. Homologs of Paris green. I. Lower members of acetic acid series. Jour. Econ. Ent. **28**(4):710–14. Aug.

Dearborn, F. E. 1936. Homologs of Paris green. II. Higher members of acetic acid series. Jour. Econ. Ent. **29**(2):445–9. Apr.

Dearborn, F. E. 1937a. Homologs of Paris green. III. Members of the oleic and linoleic acid series. Jour. Econ. Ent. **30**(1):140–3. Feb.

Dearborn, F. E. 1937b. Homologs of Paris green. IV. Insecticides prepared from animal and vegetable oils. To be published.

Dobroscky, I. D. 1935. Preliminary report on the fluorine compounds as insecticides. Jour. Econ. Ent. **28**(3):627–37. June.

W. W. Fassig and F. L. Campbell, *Ohio State University, Columbus.*—5-14-37.

At a meeting of the Southern Plant Board at Birmingham on April 17, the quarantine committee presented the draft of a standardized quarantine relating to the phony peach disease with the recommendation that it be uniformly adopted by the various states infected with the disease. Willingness to promulgate such a quarantine was expressed by officers of all states in attendance, and Alabama, Georgia, Mississippi and Tennessee each established quarantines in May in line with the standard requirements. The movement of the host plants into, within, or from the infected state issuing such a quarantine is placed under control, under these orders, making it unnecessary for the uninfected states to take quarantine action with respect to the disease. A disease-free radius of a mile around shipping nurseries is required, and any county or state found uninfected for three years may be freed from the restrictions of the quarantine. Culling of nursery stock for the peach borer is no longer required. Nine entire states and parts of eight others are uniformly designated as infected.

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RED TAPE *vs.* RESEARCH

The old and excellent formula for successful research, "Select the right man, then turn him loose," is no longer in effect. It has been superseded by a political regime of red tape in which many research workers are well-nigh hopelessly entangled. During the past few years seemingly there has been a growing tendency to encumber scientific investigators (including entomologists) with innumerable restrictions and regulations. This has long been true in the federal government, and at present some of the states are not far behind in this respect.

Now, in any large organization, it is probably necessary to impose suitable rules and regulations, but these should be as simple as possible. The researcher must have his mind on his problem. He thinks of it day and night. He should not be penalized if he works overtime and at irregular hours to gain points in the habits or life history of an insect which might be missed altogether if put off until the next day. If regulations are carried to extremes, such an investigator cannot have much time to think on his problem because a major portion of it will be needed to comply with the regulations. Thus red tape becomes his chief problem instead of research, and science is the loser.

What are some of these regulations? Well, budgets must be prepared, sometimes covering future time from one to three years in advance. No one can foretell what emergencies may arise during that time that may necessitate a change in the allotments. Then, except for a few emergency materials, all supplies must be procured by a purchase order accompanied by a commitment sheet. After checking the shipment the research man must report the receipt of the goods to the office and approve the invoice when received. He must make out detailed plan of procedure for each project and may be required to furnish daily, weekly, monthly, quarterly, semi-annual and annual reports, with additional reports on certain projects from time to time. Probably he will be required to make frequent financial statements, including his travel expenses, automobile mileage and the like, and to attend innumerable conferences.

On completion of the work on each project he must prepare the final report, and before it is published this must pass through the editorial office and be subjected to certain changes in arrangement, style, punctuation and citation. As the editorial supervision is often given by someone who knows all too little about the subject, changes are made which, unintentionally, may change the author's meaning. He must catch these in reading the proof, for the author instead of the editor is held responsible for the entire contents of the paper when published.

Some of these requirements are probably advisable and necessary, yet in some cases the system seems top-heavy. It must be remembered that a system of regulations is a means to an end and not the end itself.

No system is workable unless reason and good intelligent men are behind it. Good research men are all too few and should be permitted to carry on their scientific work with the least possible hindrance. Too much accounting and clerical work is bound to reduce their research activity. Rather let their time and thought be devoted to the problems that they are trying to solve.

Some investigators adapt themselves more readily than others to the reels of red tape and are singled out, soon appointed to executive positions and (more's the pity) paid much larger salaries than for research. It is considered a promotion. The investigator may have a family to support and needs the money, so he gladly accepts, but his research days are over. Many specific instances might be cited where first-class research ability has been sacrificed to fill executive positions. Is this as it should be? Rather, should there not be a premium on research, which after all is the basis of all progress in civilization, and larger salaries paid for it, and let the executive positions be filled by men who have little or no ability or training for research?

There is nothing to be gained and much to be lost by stopping a man's productive research to make of him a mediocre or indifferent executive, a position that can be filled just as well, or better, by a non-research man.

W. E. Britton—6-25-37.

Current Notes

UNIVERSITY OF MAINE AWARDS EDITH M. PATCH HONORARY SC. D.

In recognition of her scientific achievements and in appreciation of her service to the public during thirty-three years as head of the Department of Entomology in the Maine Agricultural Experiment Station, Edith M. Patch was awarded the honorary degree of Doctor of Science by the University of Maine, June 14.

The following is a statement made by Dr. Arthur A. Hauck, President of the University of Maine, in conferring the degree upon Dr. Patch.

EDITH MARION PATCH

Native of Massachusetts, a graduate of the University of Minnesota, Master of Science from the University of Maine, and Doctor of Philosophy from Cornell University; since 1904, head of the Department of Entomology of the Maine Agricultural Experiment Station; successful teacher, author of many volumes of nature stories whose charm and accuracy have delighted nature lovers old and young, scientist whose contributions to the knowledge of entomology have been invaluable to agriculturists throughout the world and have brought her the honor of election as President of the Entomological Society of America in 1930, and in 1937 as President of the American Nature Study Society.

Your services as a member of the faculty have brought distinction and honor to the University of Maine, and the trustees take particular pride and pleasure in conferring upon you the degree of *Doctor of Science*.

Dr. Frank H. Lathrop, who for some years has been on the staff of the Maine Agricultural Experiment Station, Orono, has recently been appointed head of the station department of entomology, to succeed Dr. Edith M. Patch, who retired June 30.

B. A. Osterberger, assistant entomologist of the Louisiana Agricultural Experiment Station, has returned from Kansas State College, where he spent the year in graduate work under the direction of Dr. G. A. Dean.

FORMAL DEDICATION OF THE MELLON INSTITUTE

At Pittsburgh, Pa., on May 6 and 7, 1937, a great temple of science was formally dedicated, The Mellon Institute—dedicated to research in all branches of science and engineering "in order to promote a fuller life and happier existence for the human race." So declared Andrew W. Mellon, former Secretary of the Treasury in his dedicatory founders' address. Mr. Mellon was followed by Richard K. Mellon, son of Richard B. Mellon, deceased co-founder of the Institute, who gave a resumé of his father's great interest in the development of the industrial fellowship plans. Addresses by three Nobel Prize winners followed, *viz*: Dr. Irving Langmuir, Dr. Harold C. Urey and Dr. Wm. P. Murphy.

The Institute was conceived and planned by the founders, as Richard K. Mellon stated, following the reading of an impressive chapter on industrial fellowships in a book on industrial chemistry by Professor Robert Kennedy Duncan of the University of Kansas.

The Mellon Institute, Pittsburgh, Pa.

Invited to the University of Pittsburgh in 1910, Professor Duncan was authorized to carry out his suggested plans for industrial fellowships, which were so favorably received that in 1913 the Mellon Institute was founded on a permanent basis and guaranteed necessary support. For a number of years the Institute was identified as a part of the University of Pittsburgh, but in 1927 it was separately incorporated and since then its own board of trustees and executive staff have had control.

The Institute combines the opportunities of a great experimental station provided with every conceivable appliance and condition for undisturbed investigation, with its function as a training school in ultimate research.

Nearly 4000 American companies have been served by the Institute during its twenty-six years of existence. Based on the results of its research, several entirely new industries have been formed, and many novel processes and new products have been offered to the world.

Heretofore, great emphasis has been placed on research in chemistry and engineering, but Andrew W. Mellon in his dedicatory address expressed a desire to extend their study and labors quite definitely toward the biological field, whereby alleviation of human suffering may be accomplished.

The massive and beautiful building must be visited for appreciation of its remarkable beauty and adaptation to its purposes. Many years of planning by Dr. Duncan (now deceased), and more recently by Director Edward R. Weidlein and Dr. W. A. Hamor, along with the architects, have provided the most complete and modern research equipment available in a single building in the world.

It is said that the research worker need not go outside the building for any applicance, tool, machine, apparatus, material or chemical. Excellent library facilities, specialists on computations, experts in all lines of science, and withal a fraternity of trained men combine to form a most delightful and helpful research atmosphere.

Members of our associations of entomologists should make an effort to visit the Institute

as soon as convenient, and likewise should write for the 20-page illustrated booklet "A Trip Through Mellon Institute."

I consider it a great privilege to have represented the American Association of Economic Entomologists at the formal dedication exercises upon the request of our President, Dr. Bishopp, and Secretary Cory.

J. G. SANDERS.—5-27-37.

UNDER a new appropriation by the Illinois state legislature, a Natural Resources building is planned for construction on the campus of the University of Illinois. The building will house offices and laboratories of the Illinois State Natural History Survey and affiliated surveys. Under the new biennial appropriation, the general conservation program of the Natural History Survey will be expanded.

THERE will be no meeting of the Rocky Mountain Conference of Entomologists in 1937, according to George M. List, secretary. It is hoped that the meetings will be resumed in 1938.

DR. H. H. KNIGHT, of Iowa State College, will join the staff of the Illinois Natural History Survey in August to conclude work on the Miridae of Illinois, a project which he has been carrying out under temporary summer appointments with the Survey for several years. DR. W. E. MCCAULEY will join the staff of the Illinois State Natural History Survey September 1, under an appropriation made available July 1, as assistant entomologist to work on control of insect outbreaks. DR. B. D. BURKS has been appointed full time assistant entomologist of the Survey, to work on insect parasites.

Horticultural Inspection Notes

LATVIA has been added to the list of countries from which potatoes may be shipped to the United States, the Department of Agriculture announced on March 27, 1937. Officials of the Latvian government have presented evidence that their country is free from the potato wart and other injurious potato diseases and insect pests which are new to or not widely prevalent in the United States. The Bureau of Entomology and Plant Quarantine finds that Latvia has met all the conditions of the Regulations Governing the Importation of Potatoes into the United States and in consequence that Bureau announced it will now issue permits for the entry of potatoes certified as having been grown in Latvia.

ACTION on the part of the Oregon State Department of Agriculture in February 1937 included the repeal of the quarantine relating to the vegetable weevil in California; placing interstate and intrastate quarantines relating to the satin moth; placing a quarantine on account of infestations of the tomato pinworm in nine states, Hawaii and Mexico; extending the cherry fruitfly quarantine to include two Idaho counties, and the alfalfa weevil quarantine to additional counties in Colorado, Idaho and Nevada; extending the area restricted under the peach mosaic embargo to two California counties; providing a third dosage schedule with which potatoes may be fumigated for the tuber moth in lieu of inspection; removing the District of Columbia, Georgia, Rhode Island and South Carolina from the states to which the vetch weevil quarantine applies; and modifying the European corn borer embargo by providing for entry of certified host plants. Other Oregon quarantines were reissued without material change.

ALABAMA, Georgia and Tennessee have recently issued proclamations declaring the phony peach disease a public nuisance, and in Mississippi a similar order was recently extended to apply to 33 counties in that state.

REVISION of the California quarantine relating to the cherry fruit fly, issued April 20, 1937, adds Coos and Malheur counties, Ore., to the noninfested area and places Union county, Ore., and Spokane county, Wash., under prohibitive quarantine.

"SUMMARY of State and Territorial Plant Quarantines Affecting Interstate Shipments," issued as Miscellaneous Publication No. 80 of the U. S. Department of Agriculture, was revised in March 1937 to cover quarantine changes and is now off the press.